

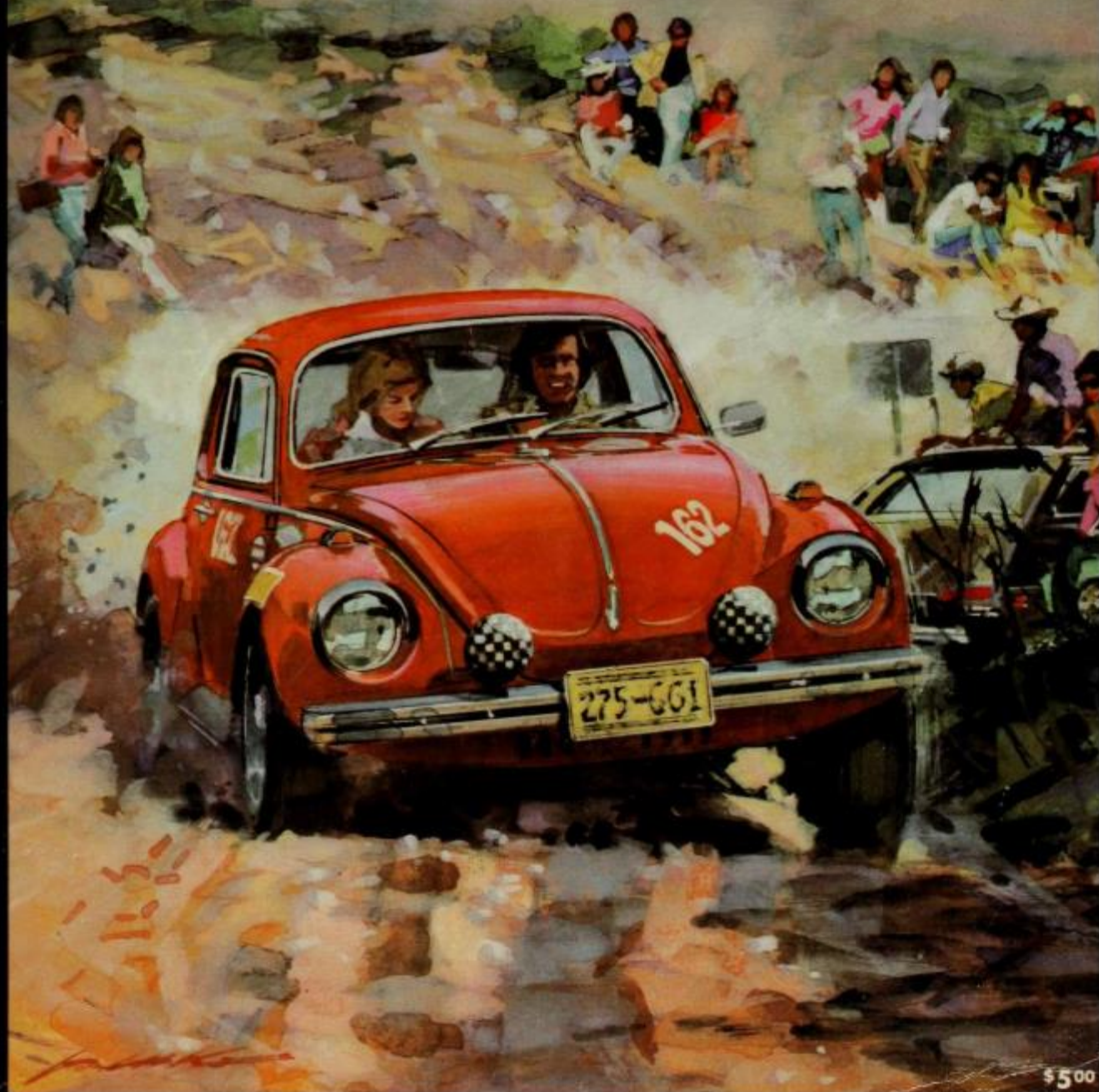


CLYMER
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VOLKSWAGEN

SERVICE • REPAIR HANDBOOK

Beetle, Super Beetle, Karmann Ghia • 1961-1972



\$5.00

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SERVICE • REPAIR HANDBOOK

**Beetle, Super Beetle,
Karmann Ghia • 1961-1972**

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CHAPTER ONE

GENERAL INFORMATION

The Volkswagen Beetle and Karmann Ghia changed far more from 1961 to the present than exterior appearance indicates. Engine displacement and horsepower increased steadily from 1200cc and 40 hp to 1600cc and 60 hp. Beginning in 1968, two transmissions were offered; the 4-speed fully synchronized, available since 1961, and a new Automatic Stick Shift.

With the introduction of Automatic Stick Shift, VW dropped the single joint swing axle in favor of a double joint axle with diagonal trailing arms similar to the 911 Porsche.

Even the front suspension has changed. For the 1971 & 1972 Super Beetle, Volkswagen switched to its own version of the McPherson strut suspension used on several other cars including the VW 411. The culmination of these changes is the Super Beetle—slightly longer, better handling, better riding and more powerful, but basically unchanged.

This chapter includes general specifications for all models from 1961-1972. See **Table 1**. **Table 2** matches chassis numbers to engine numbers.

WHAT YEAR IS IT?

It's not easy to tell one year from another. External changes throughout the years have been relatively minor. The only **positive** way to tell the year is by chassis number. Volkswagen

began a chassis numbering sequence that ran consecutively from the 1940's through 1964. To determine the year, refer to **Figure 1** or **Table 2** and find the range your chassis number fits.

Beginning in 1965, VW incorporated the year and model in the chassis number. The first 2 digits identify the model as a Beetle (11) or a Karmann Ghia (14). The 3rd digit is the last digit of the year, e.g., 5 would indicate 1965 and 2 would indicate 1972. The last 6 to 7 digits are the chassis serial number.

Figure 2 shows the chassis number and engine number location. Note the chassis number:

- Stamped on the frame tunnel under the rear seat.
- On the ID plate behind the spare tire on all except Super Beetles.
- On the ID plate next to the front hood lock on Super Beetles.
- On all cars since January 1, 1969, at the top edge of the instrument panel.

The engine number is stamped on the generator support flange as shown in the figure. Note the code letter preceding the numbers.

Figure 1 shows all changes which occurred from 1961 to the present. But remember, the presence of one or more of these changes does not identify a particular model year. Parts are

TABLE 1 GENERAL SPECIFICATIONS

	1961-1966	1967
Overall length		
Sedan & Convertible	160" (4070mm)	160" (4070mm)
Karmann Ghia	163" (4110mm)	163" (4110mm)
Super Beetle (Sedan & Convertible)	— — —	— — —
Overall width		
Sedan & Convertible	60.6" (1540mm)	60.6" (1540mm)
Karmann Ghia	64.3" (1634mm)	64.3" (1634mm)
Super Beetle (Sedan & Convertible)	— — —	— — —
Wheelbase		
Sedan, Karmann Ghia, & Convertible	94.5" (2400mm)	94.5" (2400mm)
Super Beetle (Sedan & Convertible)	— — —	— — —
Track		
Sedan, Karmann Ghia, & Convertible		
Front	51.4" (1305mm)	51.4" (1305mm)
Rear	51.2" (1300mm)	51.2" (1300mm)
Track		
Super Beetle (Sedan & Convertible)		
Front	— — —	— — —
Rear	— — —	— — —
Turning Circle		
Sedan, Karmann Ghia, & Convertible	34'6" (10.5m)	34'6" (10.5m)
Super Beetle (Sedan & Convertible)	— — —	— — —
Ground clearance (fully laden)	6" (152mm)	6" (152mm)
Curb weight		
Sedan	1720 lb (780 kg)	1764 lb (800 kg)
Convertible (all)	1808 lb (820 kg)	1852 lb (840 kg)
Karmann Ghia	1830 lb (830 kg)	1852 lb (840 kg)
Super Beetle (Sedan)	— — —	— — —
Maximum load		
Sedan	838 lb (380 kg)	838 lb (380 kg)
Convertible (all)	794 lb (360 kg)	794 lb (360 kg)
Karmann Ghia	727 lb (330 kg)	727 lb (330 kg)
Super Beetle (Sedan)	— — —	— — —
Maximum total weight		
Sedan	2556 lb (1160 kg)	2602 lb (1180 kg)
Convertible (all)	2600 lb (1180 kg)	2645 lb (1200 kg)
Super Beetle (Sedan)	— — —	— — —

TABLE 1 GENERAL SPECIFICATIONS, Continued

	1968	1969
Overall length		
Sedan & Convertible	158.6" (4030mm)	158.6" (4030mm)
Karmann Ghia	163" (4110mm)	163" (4110mm)
Super Beetle (Sedan & Convertible)	— — —	— — —
Overall width		
Sedan & Convertible	60.6" (1540mm)	61" (1550mm)
Karmann Ghia	64.3" (1634mm)	64.3" (1634mm)
Super Beetle (Sedan & Convertible)	— — —	— — —
Wheelbase		
Sedan, Karmann Ghia, & Convertible	94.5" (2400mm)	94.5" (2400mm)
Super Beetle (Sedan & Convertible)	— — —	— — —
Track		
Sedan, Karmann Ghia, & Convertible		
Front	51.6" (1310mm)	51.6" (1310mm)
Rear	53.2" (1350mm)	53.2" (1350mm)
Track		
Super Beetle (Sedan & Convertible)		
Front	— — —	— — —
Rear	— — —	— — —
Turning circle		
Sedan, Karmann Ghia, & Convertible	34'6" (10.5m)	34'6" (10.5m)
Super Beetle (Sedan & Convertible)	— — —	— — —
Ground clearance (fully laden)	6" (152mm)	6" (152mm)
Curb weight		
Sedan	1812 lb (822 kg)	1808 lb (820 kg)
Convertible (all)	1922 lb (872 kg)	1918 lb (870 kg)
Karmann Ghia	1918 lb (870 kg)	1918 lb (870 kg)
Super Beetle (Sedan)	— — —	— — —
Maximum load		
Sedan	838 lb (380 kg)	838 lb (380 kg)
Convertible (all)	794 lb (360 kg)	794 lb (360 kg)
Karmann Ghia	727 lb (330 kg)	727 lb (330 kg)
Super Beetle (Sedan)	— — —	— — —
Maximum total weight		
Sedan	2646 lb (1200 kg)	2646 lb (1200 kg)
Convertible (all)	2712 lb (1230 kg)	2712 lb (1230 kg)
Super Beetle (Sedan)	— — —	— — —

TABLE 1 GENERAL SPECIFICATIONS, Continued

	1970	1971-1972
Overall length		
Sedan & Convertible	158.6" (4030mm)	158.6" (4030mm)
Karmann Ghia	163" (4110mm)	162.6" (4140mm)
Super Beetle (Sedan & Convertible)	— — —	160.6" (4080mm)
Overall width		
Sedan & Convertible	61" (1550mm)	61" (1550mm)
Karmann Ghia	64.3" (1634mm)	64.3" (1634mm)
Super Beetle (Sedan & Convertible)	— — —	62.3" (1585mm)
Wheelbase		
Sedan, Karmann Ghia, & Convertible	94.5" (2400mm)	94.5" (2400mm)
Super Beetle (Sedan & Convertible)	— — —	95.3" (2420mm)
Track		
Sedan, Karmann Ghia, & Convertible		
Front	51.6" (1310mm)	51.6" (1310mm)
Rear	53.2" (1350mm)	53.2" (1350mm)
Track		
Super Beetle (Sedan & Convertible)		
Front	— — —	54.1" (1375mm)
Rear	— — —	53.1" (1350mm)
Turning circle		
Sedan, Karmann Ghia, & Convertible	34'6" (10.5m)	34'6" (10.5m)
Super Beetle (Sedan & Convertible)	— — —	31'5" (9.6m)
Ground clearance (fully laden)	6" (152mm)	6" (152mm)
Curb weight		
Sedan	1808 lb (820 kg)	1808 lb (820 kg)
Convertible (all)	1918 lb (870 kg)	2028 lb (920 kg)
Karmann Ghia	1918 lb (870 kg)	1918 lb (870 kg)
Super Beetle (Sedan)	— — —	1918 lb (870 kg)
Maximum load		
Sedan	838 lb (380 kg)	838 lb (380 kg)
Convertible (all)	794 lb (360 kg)	794 lb (360 kg)
Karmann Ghia	727 lb (330 kg)	727 lb (330 kg)
Super Beetle (Sedan)	— — —	881 lb (400 kg)
Maximum total weight		
Sedan	2646 lb (1200 kg)	2646 lb (1200 kg)
Convertible (all)	2712 lb (1230 kg)	2821 lb (1280 kg)
Super Beetle (Sedan)	— — —	2799 lb (1270 kg)

Table 2 ENGINE AND CHASSIS NUMBERS

Year	Chassis Number	Engine Number	Disp.	HP
1961	3,192,507 - 4,010,994	5,000,001 - 8,309,892		
1962	4,010,995 - 4,846,835			
1963	4,846,836 - 5,677,118		1200	40
1964	5,677,119 - 6,502,399			
1965	115 000 001 - 145 000 001 -	D	1200	40
1966	116 000 001 - 146 000 001 -	F	1300	50
1967	117 000 001 - 147 000 001 -			
1968	118 000 001 - 148 000 001 -	H	1500	53
1969	119 000 001 - 149 000 001 -			
1970	1102 000 001 - 1402 000 001 -	B	1600	57
1971	1112 000 001 - 1412 000 001 -	AE	1600	60
1972	1122 000 001 - 1422 000 001 -			

very easily changed, and the previous owner may have up-dated his Beetle. Use Figure 1 as a guide. Then check chassis **and** engine number.

PARTS REPLACEMENT

Volkswagen makes frequent changes during a model year; some minor, some relatively major. When you order parts from the dealer or other parts distributor, **always order by engine and chassis number**. Write the numbers down and carry them in your wallet.

SERVICE HINTS

Throughout this manual keep in mind two conventions. "Front" refers to the front of the car. The front of any component such as the engine or transaxle is that end which faces towards the front of the car. The left and right side of the car refer to a person sitting in the car facing forward. For example, the steering

wheel is on the left side. These rules are simple, but even experienced mechanics occasionally become disoriented.

MANUAL ORGANIZATION

This book provides service information and procedures for all Volkswagen Beetles and Karmann Ghias built for the U.S. market from 1961 to 1972. All dimensions and capacities are expressed in inch units familiar to U.S. mechanics, as well as in metric units. Metric tools **are required** to work on the VW.

This chapter provides general information and specifications for VW Beetles and Ghias. Figures and tables show the location of all identification tags, and permit positive year identification.

Chapter Two explains all periodic lubrication and routine maintenance required to keep your car in top running condition. Chapter Two also

①

1972 BEETLE AND SUPER BEETLE



1. Larger rear window.
2. Four sets of louvers on rear hood (all models).
3. Enlarged outer door handle finger recesses and trigger.
4. Lid over rear luggage area.
5. New safety steering wheel.
6. Rubber body mounts to reduce noise.
7. Windshield wiper switch on steering column.
8. Modified brake warning light circuit.

9. Lower compression ratio.
10. Pistons have recessed crowns.
11. Modified choke on carburetor.
12. Modified muffler and preheater pipe for faster preheating.
13. Preheated air controlled by temperature and engine vacuum.
14. Special system on automatic stick shifts to reduce nitrogen oxides.



1971 BEETLE

1. Increased horsepower, from 57 to 60.
2. Flow-through ventilation with exhaust ports behind rear side windows.
3. Headlights automatically go off and parking lights stay on when ignition is turned off.
4. Larger taillights.



1971 SUPER BEETLE

1. In addition to major improvements built into the 1971 Beetle, the Super Beetle features fan-powered flow-through ventilation.
2. Nearly double the trunk space of the Beetle. Spare tire positioned horizontally under trunk floor.
3. New coil spring front suspension giving the car a wider front track and tighter turning circle.
4. Carpeted floor.
5. Rubber bumper inserts.



1970



Chassis numbers:
11 0 2000001—11 0 3096945

1

1. Air intake slots on engine lid.
2. Increased horsepower (from 53 to 57) and displacement (from 1500 cc to 1600 cc).
3. Enlarged front turn signals (combined with side marker lights).
4. Reflectors mounted on rear bumper.
5. Side reflectors built into taillight housing.
6. Tenths of mile indicator on odometer (also appears on late '69 models).
7. Head restraints reduced in size.
8. Buzzer sounds when door is opened and key is left in ignition.
9. Remote control knobs for warm air outlets discontinued.
10. Lock in glove compartment door.



1969



Chassis numbers:
119 000 001—119 1 093 704

1. Rear window defogger and defroster; electric heating wires on inner surface of glass.
2. Double-jointed rear axle for improved ride and handling.
3. Warning lights in speedometer identified by letters or symbols.
4. Ignition lock is combined with a locking device for the steering wheel.
5. Gas tank filler neck flap has lock which has a release under the right side of the dash panel.
6. Front hood release is located in the glove compartment.
7. Day/night rear view mirror.
8. Warm air outlets at base of the doors moved rearward; remote control knobs on door columns.



1968



Chassis numbers:
118 000 000—118 1 016 098

1. One-piece bumpers; bows and overriders eliminated (bumper height raised).
2. Head restraints combined with front seat backrests.
3. Automatic Stick Shift (optional) introduced.
4. External gas tank filler; spring-loaded flap.
5. Front hood air intake louver; push-button front hood catch.
6. Fresh air ventilating system.
7. Collapsible steering column.
8. Exhaust emission control system.
9. Flattened door handles with built in trigger release.
10. Back-up/brake lights and rear turn signals in single housing.
11. Certification sticker on door post that vehicle meets federal safety standards.



1967



Chassis numbers:
117 000 001—117 844 892

1. Increased horsepower (from 50 to 53) and displacement (from 1300 cc to 1500 cc).
2. Single-unit headlights with chrome rim; fender indented.
3. Dual brake system; front/rear operate independently.
4. Back-up lights.
5. Parking light incorporated into front turn signals.
6. Locking buttons on doors.
7. 12-volt electrical system (36-amp battery).
8. VOLKSWAGEN nameplate on engine lid.



1966



Chassis numbers:
116 000 001—116 1 021 298

1

1. Increased horsepower (from 40 to 50) and displacement (from 1200 to 1300 cc), number 1300 on engine lid.
2. Ventilating wheel slots; flat hub caps.
3. Emergency blinker switch.
4. Headlight dimmer switch mounted on turn signal.
5. Center-dash defroster outlet.
6. Semi-circular horn ring.



1965



Chassis numbers:
115 000 001—115 979 200

1. Windows enlarged; slimmer door and windshield posts.
2. Heat control levers mounted on tunnel; heater efficiency improved.
3. Rear seatback converts to platform.
4. Push-button catch on engine lid.
5. Thinner, deeply contoured front seats; increased rear seat knee room.
6. Swivel mounted sun visors.



1964



Chassis numbers:
5 677 119—6 502 399

1. Crank-operated sliding steel sunroof replaces the fabric sunroof.
2. Horn actuated by two thumb buttons, formerly by half-ring.
3. Larger license plate light.
4. Aerated vinyl material replaces nonporous leatherette seat upholstery.



1963



Chassis numbers:
4 846 836—5 677 118

1. Leatherette headliner introduced.
2. Wolfsburg hood crest dropped.
3. Folding handle for sunroof.
4. Foam insulated floor.
5. Fresh air heating.
6. Nylon window guides.



1962



Chassis numbers:
4 010 995—4 846 835

1. Spring-loaded hood.
2. Larger taillights.
3. Sliding covers on heat outlets.
4. Compressed air windshield washer.
5. Seat belt mounting points added.
6. Gas gauge; formerly reserve fuel tap.



1961



Chassis numbers:
3 192 507—4 010 994

1. Sunvisor and grab handle provided for passenger's side.
2. Increased horsepower; from 36 to 40.
3. Automatic choke introduced.
4. Transmission synchronized in all forward speeds.
5. Flatter gas tank yields increased luggage space.
6. "Quick-check" transparent brake fluid reservoir.
7. Pump-type windshield washer.
8. Non-repeat starter switch.



Chassis No. **11 1 2000012**

Model

Year

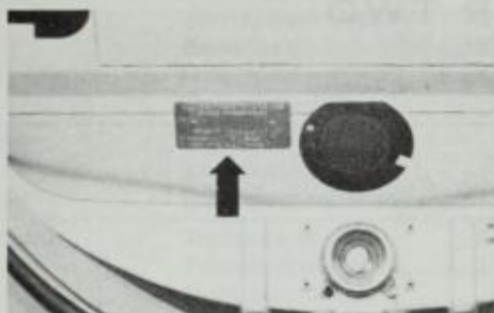
Serial Number

②

Engine No. **B 6252265**

Engine Code

Serial Number



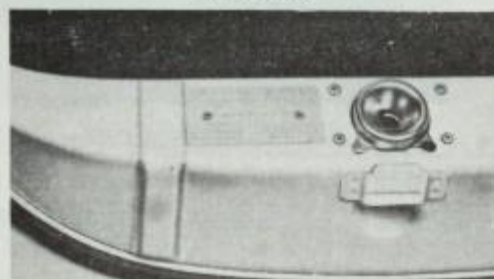
All except Super Beetle



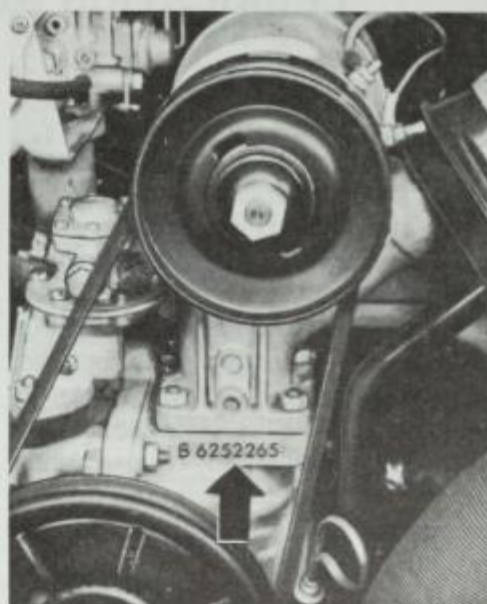
All chassis since Jan. 1, 1969



All chassis



Super Beetle



All engines

includes recommended engine tune-up procedures, eliminating the need to constantly consult chapters covering the various subassemblies.

Chapter Three provides methods and suggestions for finding and fixing troubles fast. Troubleshooting procedures discuss typical symptoms and logical methods to pinpoint the trouble. It also discusses test equipment useful for both preventive maintenance and troubleshooting.

Subsequent chapters describe specific systems such as the engine, transmission, and electrical system. Each provides complete disassembly,

repair and assembly procedures in easy to follow step-by-step form. If a repair is impractical for the home mechanic, it is so indicated. Such repairs are usually more economically and quickly done by a VW dealer or other competent repair shop. Specifications concerning a particular system are provided at the end of the applicable chapter.

Some of the procedures in this manual specify special tools. In all cases, the tool is illustrated either in actual use or alone. A well-equipped mechanic may find he can substitute other similar tools he has on hand or can fabricate his own.

CHAPTER TWO

LUBRICATION AND MAINTENANCE

To ensure good performance, dependability and safety, regular preventive maintenance is necessary. This chapter outlines periodic lubrication and maintenance for a car driven by an average owner. A car driven more than average may require more frequent attention, but even without use, rust, dirt and corrosion cause unnecessary damage. Whether performed by the owner or a Volkswagen dealer, regular routine attention helps avoid expensive repairs.

The recommended schedule in this chapter includes routine checks which are easily performed at each fuel stop, periodic checks to be performed at each oil change, and periodic maintenance to prevent future trouble. The last part of this chapter suggests a simplified engine tune-up procedure which simplifies this important task. **Table 1** summarizes all periodic maintenance required in an easy-to-use form.

ROUTINE CHECKS

The following simple checks should be performed at each fueling stop.

1. Check engine oil level. See **Figure 1**. Level should be between the 2 marks on the dipstick, but never below. Top up if necessary.
2. Check battery electrolyte level. It should be even with the top of the vertical separators. Top up with **distilled** water.



3. Check that brake fluid level is slightly above the top molded edge of the reservoir. Refer to **Figure 2**. Use VW Brake Fluid. If you use another brand, be sure it is clearly marked 70R1 for drum brake systems, and 70R3 for disc brake systems.

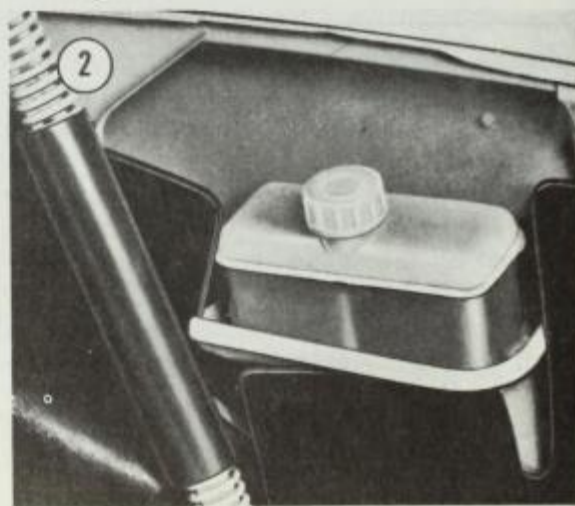
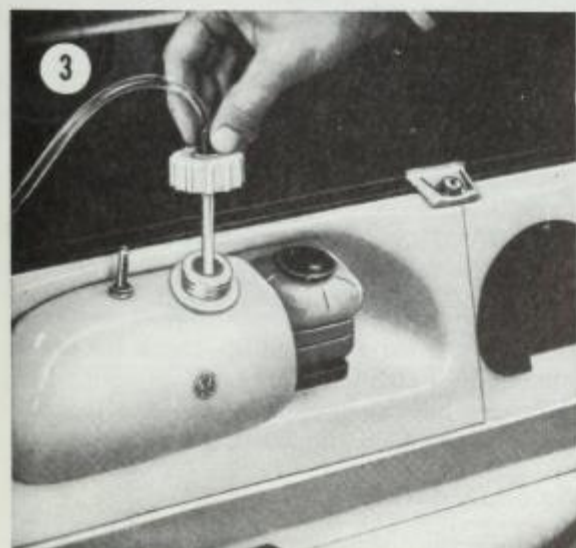


Table 1 LUBRICATION & MAINTENANCE SUMMARY

Interval	Item	Check Fluid Level	Replace	Lube	Inspect and/or Clean	Check and/or Adjust
Fuel stop	Engine oil	X				
	Battery electrolyte	X				
	Brake fluid	X				
	Windshield washer	X				
	Tire pressure					X
3000 miles	Engine oil		X			
	Air cleaner		X			
	Body mechanisms			X		
6000 miles	Transaxle oil	X				
	Torque converter	X				
	Front suspension			X		
	Distributor			X		
	Carburetor			X		
	Breaker points				X	X
	Spark plugs				X	X
	Ball joint seals				X	
	Brake linings				X	
	Fuel filter				X	
	Valve clearance					X
	Ball joint or king pin play					X
	Front end alignment					X
	Fan belt					X
12,000 miles	Spark plugs		X			X
	Breaker points		X			X
	Recirculating valve		X			
30,000 miles	Transmission oil		X			
	Wheel bearings			X	X	X

4. Check windshield washer container level as shown in Figure 3.



5. Check tire pressure when tires are cold. Table 2 lists recommended pressures.

Table 2 TIRE PRESSURES

Persons	All except Super Beetle and convertible		Super Beetle and convertible	
	Front	Rear	Front	Rear
1-2	16	24	16	27
3-5	17	26	19	27

Pressures are for standard 5.60-15 bias ply tires.
Add 1 psi to all pressures for 155 SR 15 radials.
Add 3 psi to all pressures for long, high speed trips.

PERIODIC CHECKS

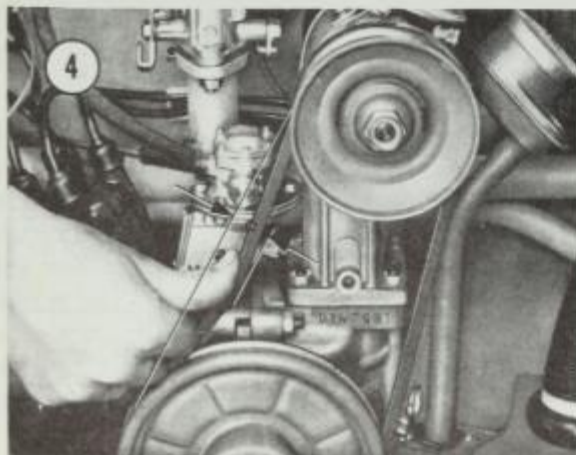
These checks are performed less frequently than routine checks. Recommended intervals are discussed below and are summarized in

Table 1. Many require that the automobile be on a hoist or jack stands.

WARNING: Do not use the tire jack when working under the car. Use only jack stands made specifically for this purpose.

Fan Belt

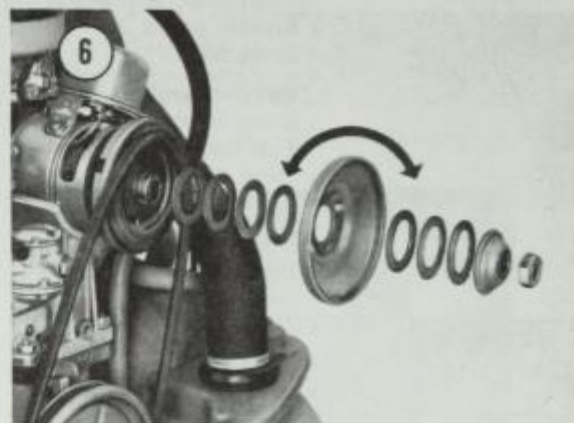
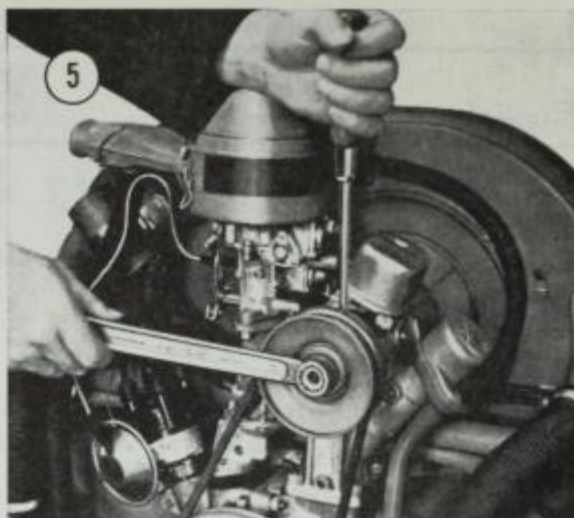
Since fan belt tension affects engine cooling and electrical charging, it is important to check it every 6000 miles. When correct, the belt should deflect about 0.6" (15mm) when pressed midway between the crankshaft and generator pulleys. See **Figure 4**. In addition, it should be possible to crank the engine over by turning the generator pulley nut with a wrench. If the belt slips, it is too loose. Check the condition of the belt also. If worn or cracked, replace it.



To adjust or replace the belt, hold a screwdriver in the cutout in the pulley as shown in **Figure 5**. Remove the nut on the end of the pulley. If installing a new belt, remove the crankshaft pulley cover plate, then remove the old belt. Install a new belt and the pulley cover plate.

Belt tension is adjusted by varying the number of shims between the pulley halves. Decreasing the number tightens the belt, increasing the number loosens the belt. Store extra shims on the outside of the pulley, under the pulley nut. See **Figure 6**.

Adjust belt tension carefully. If it is too loose, the engine can overheat and the battery may not charge. If too tight belt life will be low, and the generator bearings will wear prematurely.



A new fan belt using different material was introduced in early 1971. New belts are identified with either "D.A." or "XDA" part numbers. Deflection should be .25" instead of .6".

Manual Transaxle

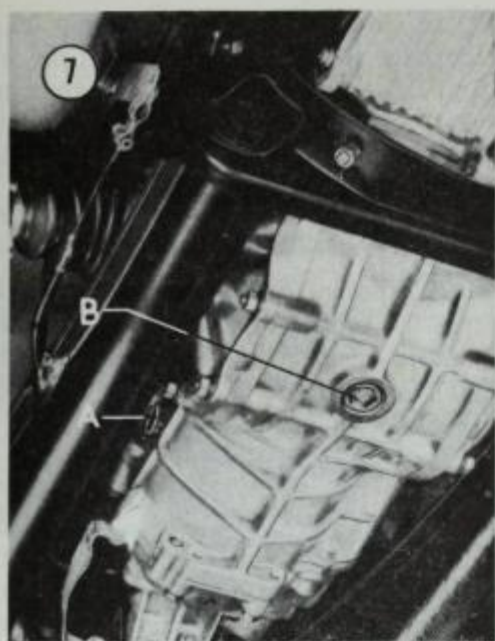
Every 6000 miles, check the oil level in the transaxle. To do this, remove the filler plug (A, **Figure 7**) and ensure the oil level reaches to the bottom of the hole. If the level is low, top up with gear oil recommended in **Table 3**.

CAUTION: Do not overfill. Before replacing plug, let any excess drain out. Excess oil can damage seals.

While the car is jacked up, check the transmission thoroughly for leaks and mounting-bolt tightness. See Chapter Nine for bolt location and recommended torque value.

Automatic Stick Shift

Every 6000 miles, check the oil level in the



transaxle in the same manner as for the manual transaxle. In addition, check the automatic transmission fluid for the torque converter. Check level on dipstick shown in **Figure 8** at the right side of the engine compartment with the engine off.

Level should be between the two marks and never below the lowest mark. Top up if necessary. Use only automatic transmission fluid marked "Dexron" with a 5-digit number preceded by the letter "B".

Steering and Suspension

Every **6000** miles check ball joint and tie rod



end dust seals. Check tie rods for tightness and damage. Check steering gear free play and adjust if necessary as described in Chapter Eleven. Check tire wear which may indicate damaged or worn suspension parts. See Chapter Three to check for king pin or ball joint play.

On 1961-1965 cars, check the steering gear oil level every **3000** miles by removing the filler plug on top of the steering gear case. The plug is accessible through an inspection plate in back of the spare tire on the left side. Oil level should reach to the bottom of the filler hole threads. Top up with SAE 90 transmission oil.

CAUTION: *Overfilling can cause seal damage and leaks.*

It is not necessary to check steering gear lubricant level on 1966-1972 cars and no filler plug is provided. Check the housing for external leaks. Top cover leaks may be repaired as described in Chapter Eleven. Other leaks indicate internal damage which involves repair by a VW dealer. See Chapter Eleven.

Table 3 RECOMMENDED LUBRICANTS AND FUEL

	Temperature Range	Recommended Type	Capacity
Engine oil	below -13°F	SAE 5W(MS)	5.3 pints (2.5 liters)
	between -13°F & 13°F	SAE 10W(MS)	
	between 5°F & 40°F	SAE 20-20W(MS)	
	between 40°F & 86°F	SAE 30(MS)	
	above 68°F	SAE 40(MS)	
Manual transaxle & automatic stick shift (except torque converter)	above 0°F	Gear Oil SAE 90	Manual
	between 0°F & -13°F	Gear Oil SAE 80	5.3 pints (2.5 liters)
	below -13°F	ATF (DEXRON)	Automatic 6.3 pints (3 liters)
Automatic stick shift torque converter	all temperatures	ATF (DEXRON)	7.6 pints (3.6 liters)
Fuel	---	91 octane	10.6 gal. (40 liters)*
		(regular)	11.1 gal. (42 liters)**

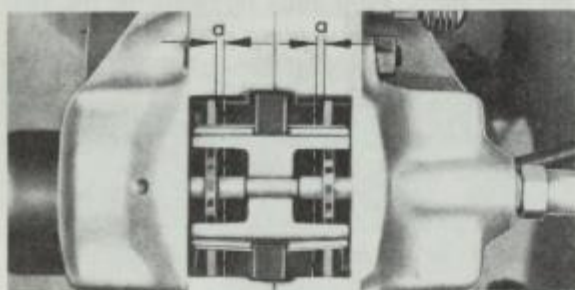
*All except Super Beetle **Super Beetle

Brakes

Every **6000** miles, check brake lining thickness. This is a simple job on the Beetle and 1961-1966 Karmann Ghia. After jacking the car up and removing the wheel, look through the brake inspection/adjustment holes in the brake drum. If linings are less than 1/16" thick, replace them. See Chapter Twelve. Bonded lining wear limit is .040" remaining thickness.

Check disc brake pads on 1967-1972 Karmann Ghia at the same interval. To do this, jack up the front of the car and remove the front wheels. Measure brake pad thickness "a" in **Figure 9**. If "a" is 0.08" (2mm) or less, **replace all 4 pads** (both wheels). See Chapter Twelve.

Check foot and hand brake adjustments which are also described in Chapter Twelve.



Warning Lamps

The engine or automatic stick shift could unknowingly be seriously damaged if a warning lamp burns out and is unable to inform the driver of a malfunction. Therefore, it is good practice to check the warning lights every **6000** miles. Replace them immediately if burned out.

To check the engine oil pressure lamp, and generator warning lamp, simply turn the ignition on without starting the engine. If either lamp does not light, replace it.

If oil pressure light **still** doesn't go on, check oil pressure switch by grounding the wire connected to it. If light works, replace switch. If light remains out, check connections and conditions of all leads.

To check the ATF temperature warning lamps, jack the rear of the car on jackstands until the tires clear the ground. Apply the hand-brake and start the engine. Shift to Drive 1. Remove the wire from the Drive 1 temperature sender (see Chapter Nine, Figure 17, for loca-

tion) and ground the wire. The lamp on the speedometer should light. Reconnect the wire. Shift to Drive 2 and repeat the procedure as in Drive 1. If the warning lamp fails to light in either or both ranges, see Chapter Three, Automatic Stick Shift Troubleshooting.

Windshield Wiper Blades

Long exposure to weather and road film hardens the rubber wiper blades and destroys their effectiveness. When blades smear or otherwise fail to clean the windshield, they should be replaced.

Tire Inspection

Every **6000** miles, check the condition of all tires. Volkswagen recommends replacing tires with tread less than 0.04" (1mm). Check local traffic regulations; many states specify other minimum tread depths. Ensure that tire wear is even over the whole surface. If not, see Tire Wear Analysis in Chapter Three.

Tire Rotation

While periodic tire rotation improves tire mileage slightly, there are several disadvantages. Unless you rotate tires yourself, the cost of rotation is greater than the savings in tires. In addition, once a tire has worn to the pattern in one position, it can cause unusual handling problems until it wears into the pattern in the new position. Volkswagen no longer recommends periodic tire rotation. Fortunately, a car as light as the VW gets relatively good tire mileage without rotation.

PERIODIC MAINTENANCE

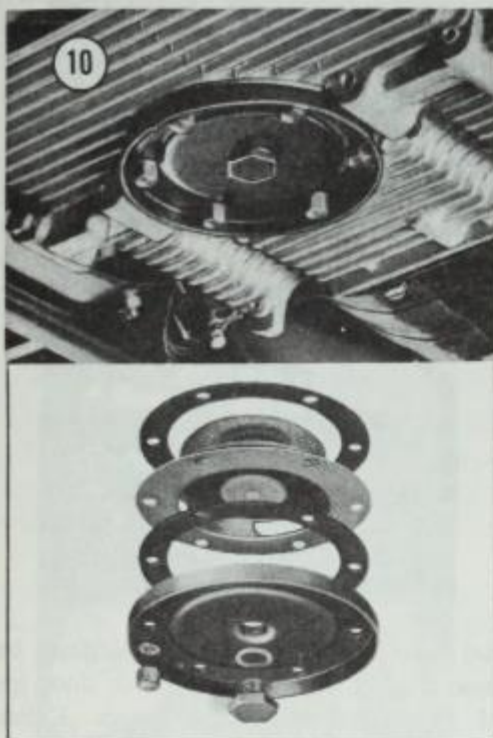
Engine Oil Change

The oil change interval varies depending on the type of driving you do. For normal driving including some city traffic, change oil every **3000** miles. If driving is primarily short distances with considerable stop-and-go city traffic, change oil every **1500** miles. Change the oil every 6-8 weeks if driving amounts to only a few hundred miles per month. In arctic climates with temperatures frequently below -13°F (-25°C) change oil every **750** miles.

Any oil used must be rated "FOR SERVICE MS", or one of the newer designations "FOR

API SERVICE SD or SE." Non-detergent oils are not recommended. See Table 3 for recommended oil grades.

To drain engine oil, remove the drain plug in the center of the oil strainer cover. Oil should always be drained when hot. Let oil drain for at least 10 minutes. When oil has drained, remove nuts securing the oil strainer and remove the strainer. See **Figure 10**. Clean all strainer parts in solvent, then reinstall them with a new gasket. Do not overtighten nuts. Install drain plug.



Remove the oil filler cap (see **Figure 11**) and add 5.3 pints (2.5 liters) of a suitable oil selected from Table 3. Check level on dipstick. The level should be between the marks or slightly above the top mark.



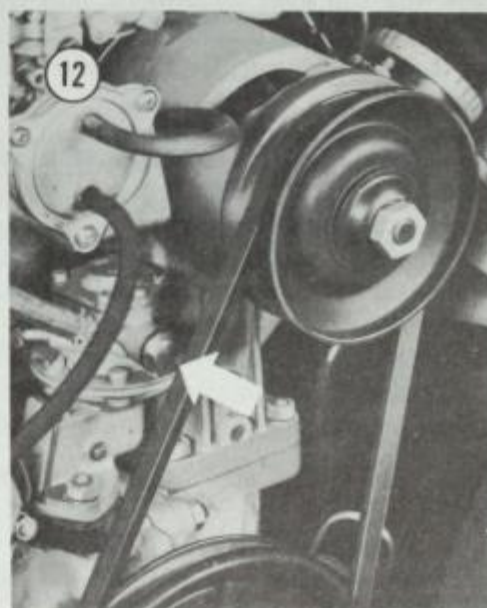
Air Cleaner

Change the air cleaner oil at the same time as the engine oil, using the same grade. Fill to the mark provided; on small air cleaners this takes about 0.6 pints (.28 liters), on larger ones about 0.9 pints (.41 liters).

To change the oil, remove the air cleaner as described in Chapter Six. Clean all sludge from the bottom part with solvent. The top part usually does not require cleaning unless conditions are very dusty or oil level has been neglected for long periods. Reinstall the air cleaner, and fill to the mark with oil.

Fuel Filter

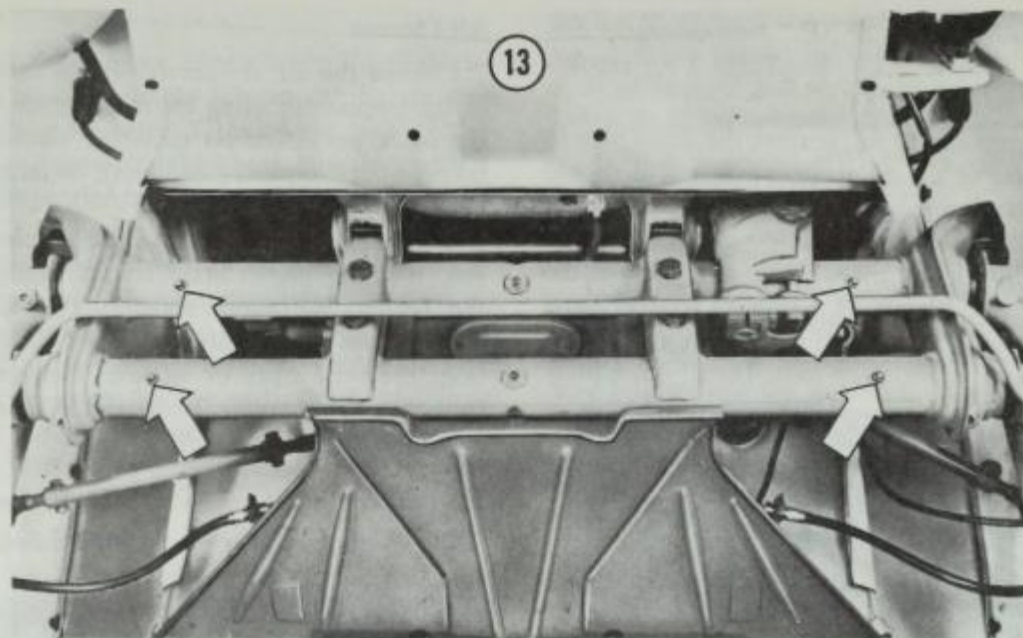
Clean the fuel filter every 6000 miles. To do this, remove the plug shown in **Figure 12** and remove the filter. Clean filter in solvent such as benzine and blow dry. Install the filter and plug.



Front Suspension Lubrication

Lubrication varies depending on type of suspension and year. Lubricate 1961-1965 models every 3000 miles, 1966-1972 models every 6000 miles. Regardless of mileage, lubricate at least once a year.

On 1961-1962 models, there are grease fittings on tie rod ends, 2 per wheel on the king pin links, and 4 on the axle tubes (see **Figure 13**). From 1963-1965, tie rods do not have fittings and require no lubrication. On 1966-1972



models with ball joint suspensions, only the 4 front axle fittings are provided; no other lubrication is required. Super Beetles require no lubrication.

Wipe each grease fitting with a clean cloth. Inject fresh lithium grease until it emerges from extremities of lubricated part. Do not get grease on rubber parts such as tires or brake hoses; wipe accidental spills off immediately.

NOTE: Raise the front of the car when lubricating to ensure that grease reaches all points.

Distributor Lubrication

Every 6,000 miles, apply a thin coat of high temperature grease to contact surfaces of the breaker cam. If there is a felt wick under the rotor (Bosch distributors) apply one drop of oil every 3000 miles.

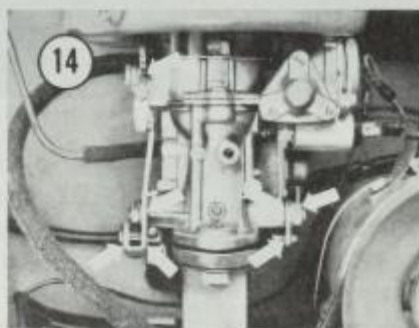
Carburetor

Every 6000 miles, lubricate the carburetor controls and linkages with powdered graphite. See Figure 14. Never use oil, which collects dust and may lead to dangerous throttle sticking.

On models **without** a fuel filter, the idle fuel jet should be removed at this time and blown clean with compressed air.

Body Maintenance

Every 6000 miles lightly grease front and rear



hood locks with molybdenum disulphide based grease. Apply 1-2 drops of oil to door hinges and front and rear hood hinges. Lubricate striker plates with a non-staining stick lube such as Door Ease.

Lubricate lock tumblers by applying a thin coat of Lubriplate, lock oil or graphite to the key. Insert the key and work the lock several times. Wipe the key clean.

Clean front seat runners once a year and grease with Lubriplate.

Exhaust System

Every 6000 miles, examine the muffler and tail pipes for rust, holes and other damage. Replace any damaged parts.

Clutch

Every 6000 miles check clutch pedal play on manual shift cars. Depress pedal by hand. Free

play should be $\frac{1}{2}$ "- $\frac{3}{4}$ ". See Chapter Eight for adjustment procedure.

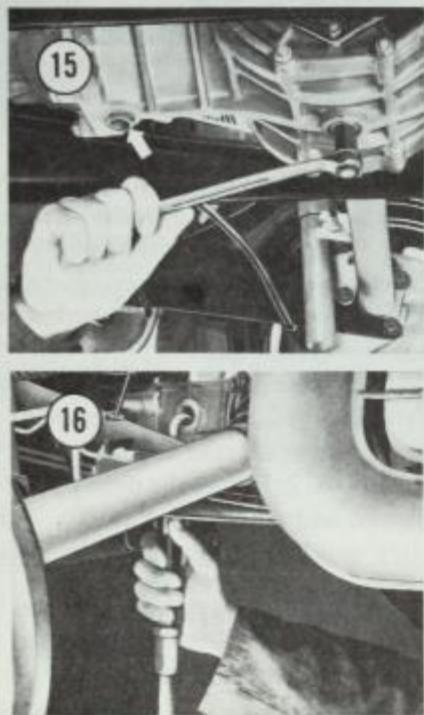
On automatic stick shifts, check clutch adjustment and gear shift switch adjustment as described in Chapter Nine.

Transaxle Oil Change

Every 30,000 miles, change oil in either the manual transaxle or automatic stick shift. It is not necessary to change automatic transmission fluid for the torque converter in automatic stick shift models.

Transaxle oil must be at normal operating temperature before draining. Remove both magnetic drain plugs (see Figure 15) and let oil drain for at least 10-15 minutes. Install the drain plugs, and remove the filler plug. Fill the transaxle slowly as shown in Figure 16. It is good practice to fill with 2 or 3 pints, wait a few minutes, then add the rest. Use 5.3 pints (2.5 liters) of an oil listed in Table 3.

CAUTION: Do not overfill. See oil level check in previous section.



Exhaust Gas Recirculator

Beetles equipped with Automatic Stick Shifts destined for California only, have a special exhaust gas recirculating system to reduce nitro-

gen oxides. Every 12,000 miles replace the recirculating valve. See Figure 17.



Wheel Bearings

Every 30,000 miles, clean, pack and adjust front wheel bearings. See Front Brake Drum Removal/Installation in Chapter Twelve for cleaning and packing procedures. See Chapter Eleven for adjustment procedure.

ENGINE TUNE-UP

In order to maintain a car in proper running condition, the engine must receive periodic tune-ups. Procedures outlined here are performed every 6000 miles. However, every 12,000 miles, spark plugs and breaker points should be replaced, not merely cleaned.

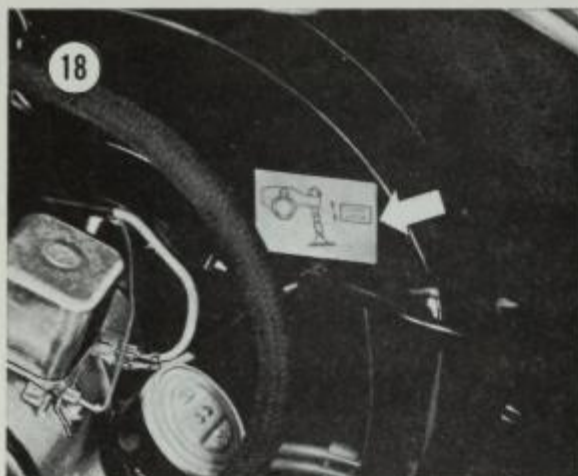
Since different systems in an engine interact to affect overall performance, tune-up must be accomplished in the following order:

1. Valve clearance adjustment
2. Ignition adjustment and timing
3. Carburetor adjustment

Valve Clearance

This is a series of simple mechanical adjustments which are performed while the engine is cold. Valve clearance for your engine must be carefully determined. If the clearance is too small, the valves may be burned or distorted. Large clearance results in excessive noise. In either case, engine power is reduced.

Normally a sticker with correct valve clearances is pasted on the fan housing. See Figure 18. If the sticker is missing or unreadable, determine valve clearance in the following manner.



1. Determine if the rocker arm shaft support studs are long or short. To do this, feel under the engine between pushrod tubes for the bottom end of the stud. If you feel the stud, you have long studs. If you cannot feel the stud, you have short studs.

NOTE: Check all 4 studs. You may have an engine with long studs on one end and short on the other. Short stud conversion kits are available to replace long studs. This must always be done to BOTH cylinder heads.

2. If you have long studs, valve clearances are as follows:

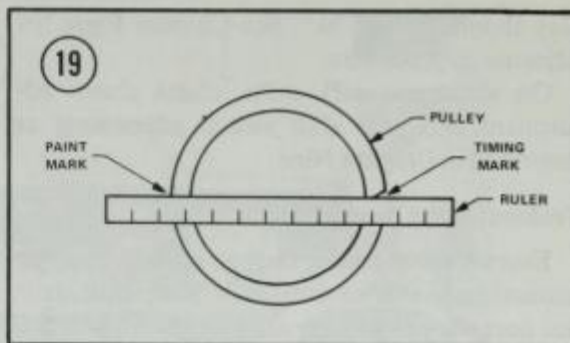
Intake—0.008" (0.2mm)
Exhaust—0.012" (0.3mm)

3. If you have short studs, valve clearances are as follows:

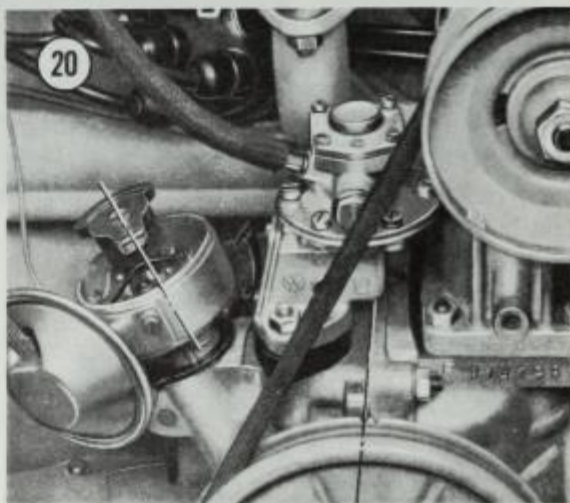
Intake—0.004" (0.1mm)
Exhaust—0.004" (0.1mm)

Before adjusting the valves, remove both rocker arm covers and the spark plugs. This makes the engine much easier to turn by hand; and plugs require cleaning or replacement at this time anyway. Turn the engine over and examine the crankshaft pulley. There should be a paint mark exactly 180° from the TDC timing mark. If not, make one. Measure across the pulley as shown in **Figure 19** to accurately locate the mark.

To adjust the valves, turn the engine over so that piston No. 1 is at TDC on its compression stroke. This is evident when the timing mark on the pulley aligns with the crankcase seam and



the rotor points to the notch on the distributor. See **Figure 20**.



Adjust valve clearance for cylinder No. 1, which is the right front cylinder. Loosen the lock nut on the adjusting screw, insert a feeler gauge and adjust to clearance given above. Tighten lock nut and recheck the clearance to be sure it has not changed.

Rotate the crankshaft pulley 180° **counterclockwise** (backwards) until the paint mark aligns with the crankcase seam. Adjust valves for cylinder No. 2. Rotate the pulley 180° counterclockwise and adjust cylinder No. 3. Rotate the pulley another 180° counterclockwise and adjust cylinder No. 4. When finished, install rocker arm covers with new gaskets.

Ignition Adjustment and Timing

Once valve clearance is properly adjusted, work on the ignition system. Examine spark plugs and compare their appearance to **Figure 21**. Electrode appearance is a good indication of performance in each cylinder and permits early recognition of trouble. Clean the plugs,

21

Normal plug appearance noted by the brown to grayish-tan deposits and slight electrode wear. This plug indicates the correct plug heat range and proper air/fuel ratio.



Red, brown, yellow and white coatings caused by fuel and oil additives. These deposits are not harmful if they remain in a powdery form.



Carbon fouling distinguished by dry, fluffy black carbon deposits which may be caused by an over-rich air/fuel mixture, excessive hand choking, clogged air filter or excessive idling.



Shiny yellow glaze on insulator cone is caused when the powdery deposits from fuel and oil additives melt. Melting occurs during hard acceleration after prolonged idling. This glaze conducts electricity and shorts out the plug.



Oil fouling indicated by wet, oily deposits caused by oil pumping past worn rings or down the intake valve guides. A hotter plug temporarily reduces oil deposits, but a plug that is too hot leads to pre-ignition and possible engine damage.



Overheated plug indicated by burned or blistered insulator tip and badly worn electrodes. This condition may be caused by pre-ignition, cooling system defects, lean air/fuel ratios, low octane fuel or over advanced ignition timing.



Spark plug condition photos courtesy of AC Spark Plug Division, General Motors Corporation.

regap them and reinstall using new gaskets. Remove plugs in order. That way, you'll know which cylinder is malfunctioning, should such be the case.

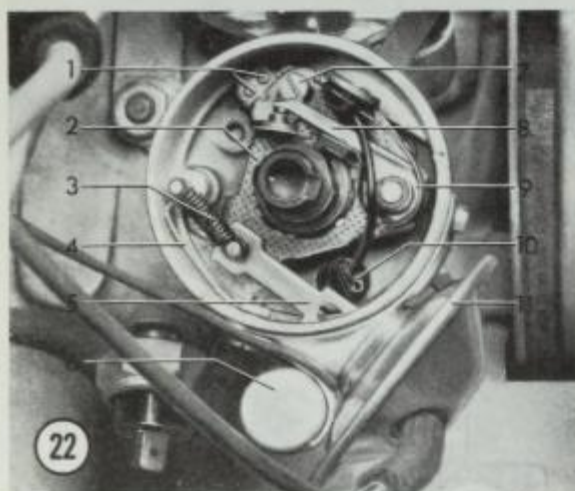
CAUTION: Ensure the rubber seals on the spark plug wires are in good condition and seal properly. Replace them if necessary. These seals prevent loss of cooling air.

Next remove the distributor cap and wipe off any dirt or corrosion. Remove the rotor. This is a good time to lubricate the distributor as discussed earlier in this chapter.

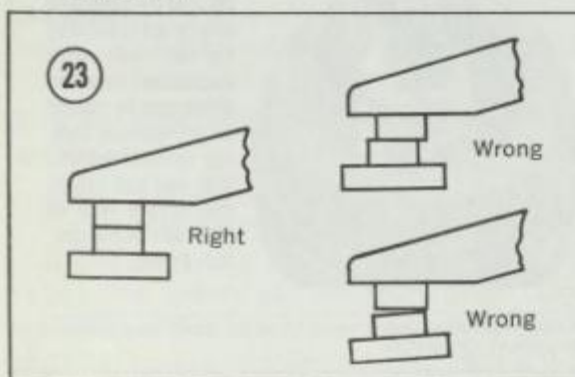
Check distributor rotor resistance at this time. Maximum allowable is 10,000 ohms. Excessive resistance may cause hard starting or high-speed miss.

Check breaker points for signs of pitting, dis-

coloration and misalignment. If this is a 12,000 mile tune-up, disconnect the primary lead to the distributor and remove the points. Note carefully how they are connected and install new points in exactly the same way. See **Figure 22**. Replace the condenser also. Check that the contacts on the points are properly aligned as shown in **Figure 23**. If not, carefully bend the fixed contact to align the contacts.



- | | |
|-----------------------------|------------------------|
| 1 - Pins and adjusting slot | 7 - Retaining screw |
| 2 - Advance plate | 8 - Breaker point |
| 3 - Return spring | 9 - Breaker arm spring |
| 4 - Ground connection | 10 - Low tension cable |
| 5 - Pull rod | 11 - Vacuum unit |
| 6 - Condenser | |



Carefully rotate the distributor body or the crankshaft pulley until a high cam lobe opens the points to the maximum gap. Loosen the screw holding the points, insert a feeler gauge in the gap and adjust to 0.016" (0.4mm). Tighten the retaining screw. More accurate measurement is possible by measuring dwell angle which should be 44-50°. Connect the dwell meter following the manufacturer's instructions.

Reconnect the primary wire and install the rotor and distributor cap. Ensure that all wires are connected properly. Tighten the distributor housing clamp screw.

After adjusting breaker gap, set the ignition timing. On 1961-1967 cars without exhaust emission control, either a test lamp or stroboscopic timing light may be used. Emission control cars may only be timed with a strobe.

Static Test Lamp Method (except exhaust emission control)

1. Remove distributor cap.
2. Crank engine over by hand until timing mark indicated in **Table 4** aligns with the crankcase seam, and the rotor points to the No. 1 mark on the distributor housing rim.
3. Loosen the distributor housing clamp screw.
4. Connect one test lamp lead to ignition coil terminal 1 and the other lead to ground.

NOTE: Use a lamp (6 or 12 volts) which matches your electrical system.

5. Switch ignition on.
6. Rotate distributor body clockwise until the contact points close (lamp off). Slowly rotate distributor counterclockwise until points just begin to open (lamp on). Tighten distributor clamp screw in this position.
7. Reinstall distributor cap and disconnect test lamp.






Stroboscopic Timing Method (exhaust emission control)

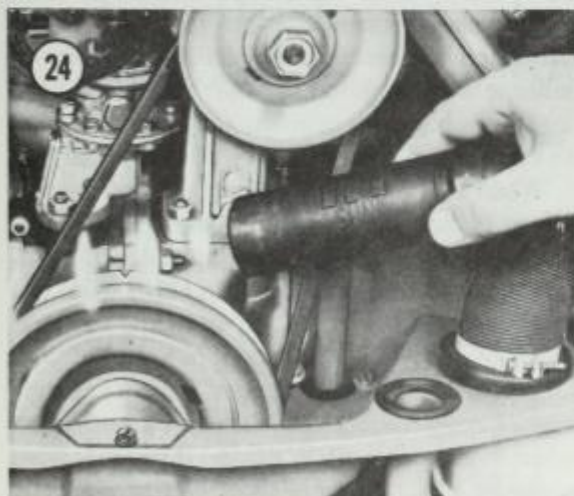
1. Select proper timing mark for your engine (see **Table 4**). Mark the notch with white chalk or paint for better visibility.
2. Connect timing light to cylinder No. 1 following manufacturer's instructions.
3. Run engine at specified speed. See **Table 4**.

NOTE: Determine from table if vacuum hose to advance must be connected or not.

4. Loosen the distributor housing and turn it until the timing notch on the pulley, illuminated by the timing light, aligns with the crankcase seam. See **Figure 24**. Tighten the distributor in this position.

Table 4 ENGINE TUNE-UP SPECIFICATIONS

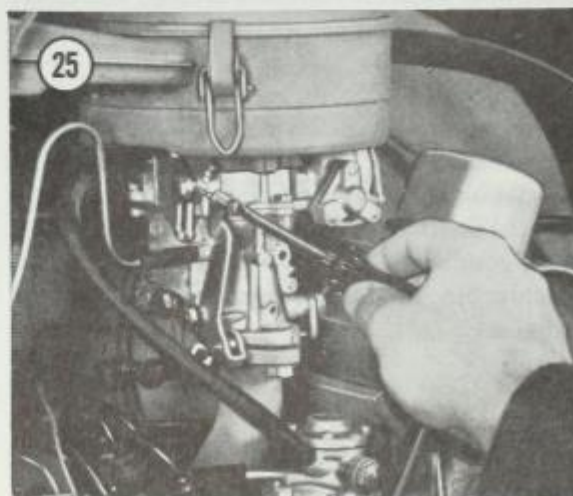
VALVE CLEARANCE			
Long studs	Intake: 0.008" (0.2mm) Exhaust: 0.012" (0.3mm)		
Short studs	Intake & Exhaust: 0.004" (0.1mm)		
IGNITION TIMING			
1961-1965	1200 engine	10° BTDC	
1966	1300 engine	7.5° BTDC	
1967	1500 engine ¹	7.5° BTDC	
1968 & 69 1970	1500 engine ² 1600 engine ²	0° TDC @ 900 rpm ³	
1971 & 1972	1600 engine ²	5° ATDC @ 900 rpm ⁴	
SPARK PLUG GAP		0.024-0.028" (0.6-0.7mm)	
SPARK PLUG TYPE		Bosch W175 T1, Champion L88	
BREAKER POINT GAP		0.016" (0.4mm)	
¹ without exhaust emission control		³ vacuum advance disconnected	
² with exhaust emission control		⁴ vacuum advance connected	

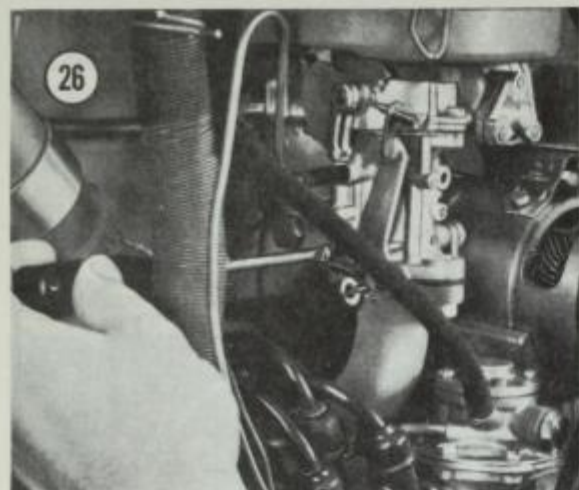


Carburetor Adjustment

Adjustments are basically the same for all carburetors. On 1961-1967 carburetors (without exhaust emission control), adjust idle speed

to 850 rpm with a tachometer. See **Figure 25**. Turn idle mixture screw in slowly until engine speed begins to drop, then back the screw out about 1/4 to 1/3 turn. See **Figure 26**.





The procedure is exactly the same for 1968-1970 exhaust emission control carburetors, except turn the idle mixture screw in until engine speed drops, then back the screw out until engine speed is maximum. Readjust idle speed to 850 rpm if it has changed. Automatic stick shifts must be in neutral for the adjustment.

CAUTION: Idle mixture on 30PICT-3 (1971-1972) carburetors is factory set and must not be adjusted.

After adjusting the carburetor, adjust the throttle positioner as described in Chapter Six.

EXHAUST EMISSION CONTROL

Harmful exhaust emissions consist primarily of carbon monoxide and unburned hydrocarbons. The relative amounts of these emissions depends on the carburetor air/fuel mixture ratio, ignition timing, engine temperature, and condition. Exhaust emission control, therefore, largely depends on proper ignition and carburetor adjustment.

Even with a properly tuned engine, excessive emissions are produced when the rear wheels drive the engine, e.g., when coasting downhill or decelerating. A throttle positioner on cars with manual shifts partially opens the throttle under these conditions. This ensures adequate air/fuel mixture to minimize unburned fuel in the exhaust.

To summarize, exhaust emission control system adjustment is no different than adjustment of any engine. It simply means ignition and carburetor must be adjusted accurately.

As a final check of emission level, connect an exhaust gas analyzer following the manufacturer's instructions. Compare carbon monoxide and hydrocarbon levels to **Table 5**. If levels are too high, double check ignition and carburetor adjustments, then refer to Chapter Three, Troubleshooting.

Table 5 EXHAUST EMISSIONS LEVELS (1968-1972 only)

Year	Carbon Monoxide (CO)	Hydrocarbons (PPM*)
1968 & 1969	2-3.5%	400 maximum
1970	2-4%	400 maximum
1971 & 1972	1.5-3%	400 maximum

*parts per million

VW DIAGNOSIS & MAINTENANCE

Service is a major reason for VW's success. An important part of their total service concept is VW Diagnosis and Maintenance, known in their advertising as "Medicar."

When you go to the dealer, your VW receives a thorough examination in a special stall equipped for this purpose. A trained diagnostician checks items on the VW Diagnosis Test Report shown on next page. He indicates repairs and maintenance needed, depending on mileage and condition of your VW. Since he is a top mechanic in addition to a diagnostician, he can explain each item to you, if necessary.

When the diagnosis is complete, you receive a copy of the test report and a cost estimate. VW will repair the items after getting your approval, or you may fix them yourself. In either case, you know exactly the condition of your VW and have the opportunity to keep it in top condition.

You should also consider VW Diagnosis when buying a used VW. Insist on a test report when buying from a VW dealer. If you buy from someone else, the small cost of the diagnosis may save you from a costly mistake.

CHAPTER THREE

TROUBLESHOOTING

Troubleshooting the Volkswagen can be a relatively simple matter if it is done logically and orderly. The first step in any troubleshooting procedure must be defining the symptoms as closely as possible. Subsequent steps involve testing and analyzing areas which could cause the symptoms. An Easter Egg Hunt approach may eventually find the trouble, but in terms of wasted time, and unnecessary parts replacement, it can be very costly.

The troubleshooting procedures in this chapter analyze typical symptoms, and show logical methods of isolation. These are not the only methods. There may be several approaches to a problem, but all methods must have one thing in common — a logical, systematic approach.

TROUBLESHOOTING INSTRUMENTS

The following equipment is necessary to properly troubleshoot any engine:

- a. Voltmeter, ammeter and ohmmeter
- b. Hydrometer
- c. Compression tester
- d. Vacuum gauge
- e. Fuel pressure gauge
- f. Dwell meter
- g. Tachometer
- h. Strobe timing light
- i. Exhaust gas analyzer

Items a-f are basic for any car. Items g-i are necessary for exhaust emission control compliance. The following is a brief description of the function of each instrument. Consult a basic repair manual for more detailed information.

Voltmeter, Ammeter & Ohmmeter

For testing the ignition system and electrical system, a good volunteer is required. For automotive use, an instrument covering 0-20 volts is satisfactory. One which also has a 0-2 volt scale is necessary for testing relays, points, or individual contacts where voltage drops are much smaller. Accuracy should be $\pm \frac{1}{2}$ volt.

An ohmmeter measures electrical resistance. This instrument is useful for checking continuity (open- and short-circuits), and testing fuses and lights.

The ammeter measures electrical current. Ammeters for automotive use should cover 0-50 amperes and 0-250 amperes. These are useful for checking battery charging and starting current. The starter and generator procedures in this manual use one to check for shorted windings.

Several inexpensive VOM's (volt-ohmmeters) combine all 3 instruments into one which fits easily in any tool box. The ammeter ranges are usually too small for automotive work, though.

Hydrometer

The hydrometer gives a useful indication of battery condition and charge by measuring the specific gravity of the electrolyte in each cell. Complete details on use and interpretation of readings is provided in Chapter Seven.

Compression Tester

The compression tester measures the compression pressure built up in each cylinder. The results when properly interpreted can indicate general cylinder and valve condition.

Most compression testers have long flexible extensions as accessories. Such an extension is necessary for the VW since the spark plug holes are deep inside the metal air cooling covers.

Many automotive books describe a "dry" compression test and a "wet" compression test. Usually these tests must be interpreted together to isolate the trouble in cylinders or valves.

Unfortunately, the wet compression test is unreliable when performed on a Volkswagen. To perform the test, about 1 tablespoon of oil is poured into the spark plug hole before checking compression. Since VW cylinders are horizontal, oil does not spread evenly over the piston crown—a necessity for this test.

Only the dry compression test should be performed on the VW. To perform the test:

1. Warm the engine to normal operating temperature. Ensure that the choke valve and throttle valve are completely open.
2. Remove the spark plugs.
3. Connect the compression tester to one cylinder following the manufacturer's instructions.
4. Have an assistant crank the engine over until there is no further rise in pressure.
5. Remove the tester and record the reading.
6. Repeat steps 3-5 for each cylinder.

When interpreting the results, actual readings are not as important as the difference between readings. All readings should be from about 114-142 psi (8-10 kg/cm²). Readings below 100 psi (7 kg/cm²) indicate an engine overhaul is due. A maximum difference of 28 psi (2 kg/cm²) between any 2 cylinders is acceptable. Greater differences indicate worn or broken rings, leaky or sticking valves, or a combination

of all. Compare with vacuum gauge reading to isolate the trouble more closely.

Vacuum Gauge

The vacuum gauge is one of the easiest instruments to use, but one of the most difficult for the inexperienced mechanic to interpret. The results when interpreted with other findings can provide valuable clues to possible trouble.

Connect the vacuum gauge with a T-connection in the hose from the carburetor to the vacuum advance on the distributor. Start engine; let it warm up thoroughly. Vacuum reading should be about 15" at idle. On cars with advance-retard vacuum units, green retard hose must be off when performing vacuum check at idle.

NOTE: Subtract 1" from reading for every 1000 feet of altitude.

Figure 1 (pages 26 and 27) shows numerous typical readings with interpretations. Results are not conclusive without comparing to other tests such as compression.

Fuel Pressure Gauge

This instrument is invaluable for evaluating fuel pump performance. Fuel system troubleshooting procedures in this chapter use a fuel pressure gauge. Usually, a vacuum gauge and fuel pressure gauge are combined.

Dwell Meter

A dwell meter measures the distance in degrees of cam rotation that the breaker points remain closed while the engine is running. Since this angle is determined by breaker point gap, dwell angle is an accurate indication of point gap.

Many tachometers intended for tuning and testing incorporate a dwell meter as well. Follow the manufacturer's instructions to measure dwell on the VW.

Tachometer

A tachometer is necessary for tuning VW's with exhaust emission control. Ignition timing and carburetor adjustments must be performed at the specified idle speed. The best instrument for this purpose is one with a range of 0-1000 or 0-2000 rpm. Extended range (0-6000 or 800) instruments lack accuracy at lower speeds. The instrument should be capable of detecting changes of 25 rpm.

1



1. NORMAL READING
18-22" at idle.



2. NORMAL READING
High lift cam with large overlap.



3. LATE IGNITION TIMING
14-17" at idle. Normal cam.



4. LATE VALVE TIMING
8-15" at idle.



5. INTAKE LEAK
Low steady reading.



6. NORMAL READING
Drops to 2, then rises to 25 when accelerator is rapidly depressed and released.



7. WORN RINGS, DILUTED OIL
Drops to 0, then rises to 22 when accelerator is rapidly depressed and released.



8. STICKING VALVE(S)
Normally steady. Intermittently flicks downward about 4".



9. LEAKY VALVE
Regular drop about 2".



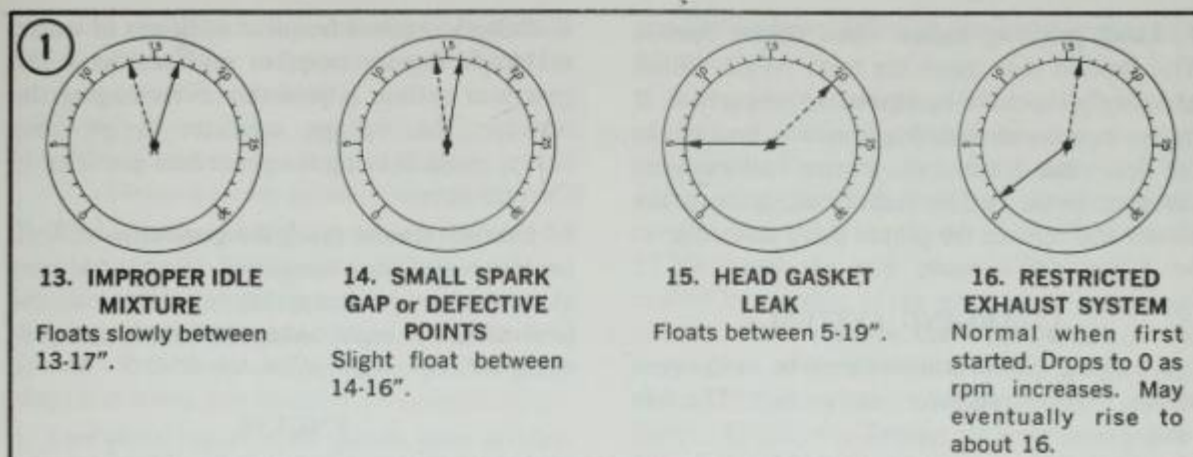
10. BURNED OR WARPED VALVE
Regular, evenly spaced down-scale flick about 4".



11. WORN VALVE GUIDES
Oscillates about 4".



12. WEAK VALVE SPRINGS
Violent oscillations (about 10") as rpm increases. Often steady at idle.



Strobe Timing Light

This instrument is necessary for VW's with exhaust emission control, and is recommended for all VW's. It permits very accurate ignition timing. By flashing a light at the precise instant cylinder No. 1 fires, the position of the crankshaft pulley at that instant can be seen. Marks on the pulley are lined up with the crankcase seam while the engine is running.

Suitable lights range from inexpensive neon bulb types (\$2-3) to powerful xenon strobe lights (\$20-40). Neon timing lights are difficult to see and must be used in dimly lit areas. Xenon strobe timing lights can be used outside in bright sunlight. Both types work on the VW; use according to the manufacturer's instructions.

Exhaust Analyzer

Of all instruments described here, this is the least likely to be owned by a home mechanic. One instrument samples the exhaust gases from the tailpipe and measures the thermal conductivity of the exhaust gas. Since different gases conduct heat at varying rates, thermal conductivity of the exhaust is a good indication of gases present.

This instrument is vital for accurately checking the effectiveness of exhaust emission control adjustments. These instruments are relatively expensive to buy, but several large rent-all dealers have them available for a modest price.

STARTER

Starter system troubles are relatively easy to isolate. The following are common symptoms and cures.

1. Engine cranks very slowly or not at all— Turn on the headlights; if the lights are very dim, most likely the battery or the connecting wires are at fault. Check the battery using the procedures described in Chapter Seven. Check the wiring for breaks, shorts, and dirty connections.

If the battery and connecting wires check good, turn the headlights on and try to crank the engine. If the lights dim drastically, the starter is probably shorted to ground. Remove the starter and test it using the procedures described in Chapter Seven.

If the lights remain bright or dim slightly when trying to crank the engine, the trouble may be in the starter, solenoid or wiring. To isolate the trouble, short the two large solenoid terminals together (NOT to ground); if the starter cranks normally, check the solenoid and wiring up to the ignition switch. If the starter still fails to crank properly, remove the starter and test it.

2. Starter turns, but does not engage with engine—This trouble is usually a defective pinion or solenoid shifting fork. It may also be that the teeth on the pinion, flywheel ring gear, or both, are worn down too far to engage properly.

3. Starter engages, but will not disengage when ignition switch is released—This trouble is usually caused by a sticking solenoid, but occasionally the pinion can jam on the flywheel. With manual transmissions, the pinion can be temporarily freed by rocking the car in high gear. Naturally, this is not possible in automatics; the starter must be removed.

4. Loud grinding noises when starter runs—

This trouble may mean the teeth on the pinion and/or flywheel are not meshing properly or it may mean the overrunning clutch is broken. In the first case, remove the starter and examine the gear teeth. In the latter case, remove the starter and replace the pinion drive assembly.

CHARGING SYSTEM

Charging system troubles may be in the generator, voltage regulator, or fan belt. The following symptoms are typical.

1. Generator warning lamp does not come on when ignition is turned on—

This may indicate a defective ignition switch, battery, voltage regulator or lamp. First, try to start the car. If it doesn't start, check the ignition switch and battery. If the car starts, find the voltage regulator and disconnect the small wire on terminal 61; this is the lamp wire. Ground the wire. If the lamp lights, the voltage regulator is defective, not properly grounded (try tightening the mounting screws), or the generator brushes are not contacting the commutator. See Chapter Seven for brush checking and replacement, and voltage regulator replacement. If the lamp does not light when the wire is grounded, the lamp is probably burned out; replace it.

2. Generator warning lamp comes on and stays on—

This usually indicates that no charging is taking place. First check fan belt tension as described in Chapter Two. Then check battery and all electrical connections in the charging system. Finally, isolate the trouble to the generator or voltage regulator. To do this, DISCONNECT VOLTAGE REGULATOR and connect a voltmeter between the generator D (armature) terminal and ground. Start the engine. Connect the generator DF (field) terminal directly to ground with a jumper wire. If generator output on voltmeter increases to a high level, the voltage regulator is defective. If the generator output remains low, the generator is defective.

3. Generator warning lamp flashes erratically—

This usually indicates the charging system is working intermittently. Check the fan belt tension, and check all electrical connections in the charging system. Check the generator brushes and the condition of the commutator.

4. Battery requires frequent additions of water, or lamps require frequent replacement—

The generator system is probably overcharging the battery. The voltage regulator is probably faulty; check it using the procedure provided in Chapter Seven.

5. Excessive noise from the generator—Check for loose generator mounting. The trouble may also be worn generator bearings. Remove the generator, and repair using the procedures provided in Chapter Seven.

ENGINE

These procedures assume the starter cranks the engine over normally. If not, refer to Starter section in this chapter.

1. Engine won't start—

This trouble could be caused by the ignition system or the fuel system. First determine if high voltage to spark plugs occurs. To do this, disconnect one of the spark plug wires. Hold the exposed wire terminal about ¼ to ½" from ground (any metal in engine compartment) with an insulated screwdriver. Crank the engine over. If sparks do not jump to ground or the sparks are very weak, the trouble may be in the ignition system. See Ignition System Troubleshooting to further isolate the trouble. If sparks occur properly, the trouble may be in the fuel system. See Fuel System Troubleshooting.

2. Engine misses steadily—

Remove one spark plug wire at a time and ground the wire. If engine miss increases, that cylinder was working properly. Reconnect the wire and check the others. When a wire is disconnected and engine miss remains the same, that cylinder is not firing. Check spark as described in step 1. If no spark occurs for one cylinder only, check distributor cap, wire, and spark plug. If spark occurs properly, check compression and intake manifold vacuum to isolate the trouble.

3. Engine misses erratically at all speeds—

Intermittent trouble like this can be difficult to find. The trouble could be in the ignition system, exhaust system (exhaust restriction), or fuel system. Follow troubleshooting procedures for these systems carefully to isolate the trouble.

4. Engine misses at idle only—

Trouble could exist anywhere in ignition system. Follow Ignition Troubleshooting procedure carefully. Trou-

ble could also exist in the carburetor idle circuit. Check idle mixture adjustment and check for restrictions in the idle circuit.

NOTE: Remove idle jet and blow clean with compressed air. Clogging is a common reason for this complaint.

5. Engine misses at high speed only—Troubles could exist in the fuel system or ignition system. Check accelerator pump operation, fuel pump delivery, fuel lines, etc., as described under Fuel System Troubleshooting. Also check spark plugs and wires. See Ignition Troubleshooting.

6. Low performance at all speeds, poor acceleration—Trouble usually exists in ignition or fuel system. Check each with the appropriate troubleshooting procedure.

7. Excessive fuel consumption—This trouble can be caused by a large variety of seemingly unrelated factors. Check for clutch slippage, brake drag, defective wheel bearings, and poor front end alignment. Check ignition system and fuel system as described later.

8. Oil pressure lamp does not light when ignition switch is on—Check the generator warning lamp. If it isn't on either, go to step 1, Charging System Troubleshooting. If only the oil pressure lamp is off, open the engine compartment lid and locate the oil pressure sender near the distributor. Ensure the wire is connected to the sender and making good contact. Pull the wire off and ground it. If the lamp lights, replace the sender. If the lamp does not light, replace the lamp.

9. Oil pressure lamp lights or flickers when engine is running—This indicates low or complete loss of oil pressure. **Stop the engine immediately;** coast to a stop with the clutch disengaged. This may simply be caused by a low oil level, or an overheating engine. Check the oil level and fan belt tension (see Chapter Two). Check for a shorted oil pressure sender with an ohmmeter or other continuity tester. Remove and clean the oil pressure relief valve(s) as described in Chapter Four. Listen for unusual noises indicating bad bearings, etc. Do not re-start the engine until you know why the light went on and the problem has been corrected.

IGNITION SYSTEM

These procedures assume the battery is in

good enough condition to crank the engine at a normal rate.

1. No spark to one plug—The only possible causes are a defective distributor cap or spark plug wire. Examine the distributor cap for moisture, dirt, carbon tracking caused by flash-over, cracks, etc.

2. No spark to any plugs—This could be caused by trouble in the primary or secondary circuits. First remove the coil wire from the center post of the distributor. Hold the wire end about 1/4" from ground with an insulated screwdriver. Crank the engine. If sparks are produced, the trouble is in the rotor or distributor cap. Remove the cap and check for burns, moisture, dirt, carbon tracking, cracks, etc. Check the rotor for excessive burning, pitting, or cracks. Replace both if necessary.

If the coil does not produce any spark, check the secondary wire for opens. If the wire is good, turn the engine over so the breaker points are open. Examine them for excessive gap, burning, pitting, looseness. Replace and adjust them if necessary. With the points open, check voltage from terminal 1 on the coil to ground with a voltmeter or test lamp. If voltage is present, the coil is probably bad. Have it checked or substitute a coil known to be good. If voltage is not present, check wire connections to coil and distributor. Temporarily disconnect the wire from terminal 1 on the coil to the distributor and measure from terminal 1 to ground. If voltage is present, the distributor is shorted; examine breaker points and connecting wires carefully. If voltage is still not present, measure terminal 15 of the coil. Voltage on terminal 15, but not on terminal 1 indicates a defective coil. No voltage on terminal 15 indicates an open wire between terminal 15 and the battery.

3. Weak spark—If the spark is so small it cannot jump from the wire 1/4-1/2" to ground, check the battery condition as described in Chapter Seven. Other causes are bad breaker points, condenser, incorrect breaker point gap, dirty or loose connections in the primary circuit or dirty or burned rotor or distributor. Also check for worn distributor cam lobes.

4. Missing—This is usually caused by fouled or damaged plugs, plugs of the wrong heat range, or incorrect plug gap. Clean and regap

the spark plugs. This trouble can also be caused by weak spark (see symptom 3) or incorrect ignition timing.

Spark Polarity

Less voltage is required to cause electron flow from a relatively hot electrode to a cooler electrode. Since the center electrode is hottest, this electrode should be negative. Electron flow is then from the center electrode to the outer electrode. From 20 to 40% **more** voltage is required to cause electron flow from the outside electrode to the hotter center electrode. This occurs when the spark voltage is positive.

The coil must be connected so that the double wire (from the battery) goes to terminal 15 and the single wire (from the distributor) goes to terminal 1. This ensures spark will be negative.

FUEL SYSTEM

Fuel system troubles must be isolated at the carburetor, fuel pump or fuel lines. These procedures assume the ignition system has been checked and properly adjusted.

1. **Engine will not start**—First, determine that fuel is delivered to carburetor. Remove the air cleaner, look into the carburetor throat and depress the accelerator several times. There should be a stream of fuel from the accelerator pump discharge tube each time the accelerator is depressed. If not, check fuel pump delivery (described later), float valve, and float adjustment (see Chapter Six).

NOTE: The engine may "diesel" in this condition (run after the switch has been turned off). Replace the valve as soon as possible.

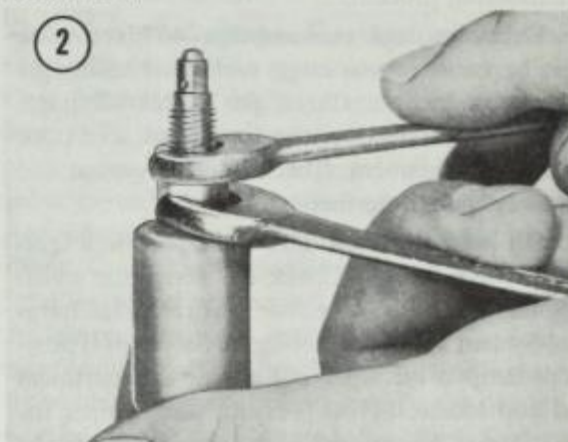
If engine still will not start, check automatic choke parts for sticking or damage. If necessary, rebuild or replace the carburetor. See Chapter Six.

2. **Engine runs at fast idle**—Usually this is caused by defective heater element. Ensure the heater wire is connected and making good contact. Correct this trouble as soon as possible; the resulting overrich mixture washes oil from cylinder walls, dilutes oil and leads to expensive wear and damage.

3. **Rough idle or engine miss with frequent**

stalling—Check idle mixture and idle speed adjustments. See Chapter Two. Clean pilot jet.

Poor idle may also be caused by a defective or dirty electromagnetic cut-off valve. Check that wire is connected to the valve (on the carburetor) and making good contact. If it is, turn the ignition switch on, disconnect the wire and touch it to the valve terminal. If the valve is working, there should be a slight click heard each time the wire touches. To by-pass the valve and keep it open, turn the small set screw next to the connector lug all the way counterclockwise. (Refer to following note). For disassembly and cleaning, see **Figure 2**. Turn the top nut counterclockwise as far as possible while holding the bottom nut.



4. **Engine "diesels" when ignition is switched off**—Check idle mixture (probably too rich) and idle speed adjustments. See Chapter Six. Check electromagnetic cut-off valve as described in step 1 of this procedure. Replace if necessary.

5. **Stumbling when accelerating from idle**—Check accelerator pump diaphragm (Chapter Six) and idle speed adjustment (Chapter Two).

6. **Engine misses at high speed or lacks power**—This indicates possible fuel starvation. Check fuel pump pressure and capacity. Clean main jet and float needle valve.

7. **Black exhaust smoke**—Black exhaust smoke means a badly overrich mixture. Check idle mixture and idle speed adjustment. Check for excessive fuel pump pressure, leaky float, or worn needle valve.

8. **Excessive fuel consumption**—Another indication of an overrich mixture. Check that

automatic choke operates. Check idle mixture and idle speed. Check for excessive fuel pump pressure, leaky float, or worn float needle valve. Also make sure jets are the proper size. Compare with specifications in Chapter Six.

Fuel Pump Pressure Testing

1. Install a "T" fitting in the fuel line close to the carburetor.
2. Connect a fuel pressure gauge to the fitting with a short tube.
3. Run the engine at 3400 rpm; fuel pressure should be about 2.8 psi (0.2 kg/cm²) with the float needle valve closed. If pressure varies appreciably, replace pump spring. If there is still a problem, replace diaphragm.
4. Stop the engine. Pressure should drop off very slowly. If pressure drops rapidly, the outlet valve is leaky.

Fuel Pump Capacity Testing

1. Disconnect the fuel line near the carburetor.
2. Fit a rubber hose over the fuel line so fuel can be directed into a graduated container with about 1 quart capacity.
3. Start engine and run for 30 seconds. There is sufficient fuel in the float chamber for this.
4. Stop the engine. The fuel pump should have delivered about 1/3-1/2 pint (150-200cc) of fuel or more in 30 seconds. Adjust stroke, as described in Chapter Six, to increase output.

EXHAUST EMISSION CONTROL

The following symptoms assume you have adjusted the ignition and carburetor as described in Chapter Two, and you have checked the results on an accurate exhaust gas analyzer.

1. **CO content too low**—Ensure idle speed is not too low. Check idle mixture adjustment (too lean). Check carburetor jets and channels. Clean and/or replace as necessary. Check engine condition with a compression and vacuum test.
2. **CO content too high**—Check idle mixture adjustment (too rich). Check for sticking air cleaner, warm air flap, and sticking or defective automatic choke. Check carburetor jets and channels. Clean and/or replace as necessary. Check engine condition with a compression and vacuum test.

3. **Hydrocarbon level too high**—Make sure throttle valve closes completely in 1970 and later carburetors. Check throttle positioner adjustment as described in Chapter Six. Check spark plug condition and gap. Check breaker points. Check ignition timing (too early). Check intake manifold for leaks. Check valve clearance (too small). Check condition of valves with compression test.

MANUAL CLUTCH

All clutch troubles, except adjustments, require engine removal to identify and cure the malfunction.

1. **Slippage**—This condition is most noticeable when accelerating in a high gear at relatively low speed. To check slippage, park the car on a level surface with the hand brake set. Shift to 2nd gear and release the clutch as if driving off. If the clutch is good, the engine will slow and stall. If the clutch slips, the engine speed will give it away.

CAUTION: This is a severe test. Perform this test only when slippage is suspected, not periodically.

Slippage results from insufficient clutch pedal free play, oil or grease on the clutch disc, worn pressure plate or weak springs. Also check for binding in the clutch cable and lever arm which may prevent full engagement.

2. **Drag or failure to release**—This trouble usually causes difficult shifting and gear clash especially when downshifting. The cause may be excessive clutch pedal free play, warped or bent pressure plate or clutch disc, excessive clutch cable guide sag, broken or loose linings, lack of lubrication in gland nut bearing or felt ring. Also check condition of main shaft splines.
3. **Chatter or grabbing**—A number of things can cause this trouble. Check cable guide sag and tightness of transmission-to-frame and engine-to-transmission mounting bolts. Check for worn or misaligned pressure plate and misaligned release plate.
4. **Other noises**—Noise usually indicates a dry or defective release or gland nut bearing. Check the bearings and replace if necessary. Also check all parts for misalignment and uneven wear.

MANUAL TRANSAXLE

Transaxle troubles are evidenced by one or more of the following symptoms:

- a. difficulty changing gears
- b. gear crash when downshifting
- c. slipping out of gear
- d. excessive noise in neutral
- e. excessive noise in gear
- f. oil leaks

Transaxle repairs, except for one oil seal, are not possible without extensive special tools. The main shaft oil seal, however, is easily replaced after removing the engine. See Chapter Nine.

Transaxle troubles are sometimes difficult to distinguish from clutch troubles. Eliminate the clutch as a source of trouble before installing a new or rebuilt transaxle.

AUTOMATIC STICK SHIFT

1. **Starter will not operate**—A starter inhibitor (neutral safety) switch permits the engine to be started in neutral only. If the switch becomes defective, replace it.
2. **Starter operates with transmission in gear**—See symptom 1.
3. **Clutch engages too slowly (slips) after gear change**—A control valve operates the clutch. Check the control valve adjustment and hose connections between control valve and carburetor. Check clutch linkage adjustment. Leaky control valve diaphragms may also cause this. See Chapter Nine for adjustments and repairs.
4. **Clutch engages too quickly (jerks) after gear change**—A control valve adjustment sets operating time of clutch. See Chapter Nine for adjustment.
5. **Clutch does not disengage (can't select drive range)**—First check solenoid fuse near ignition coil (see Chapter Seven, Figure 41). Check electrical connections to control valve solenoid; you may even have a defective solenoid. Check all vacuum hoses associated with control valve. Check clutch linkage adjustment. See Chapter Nine.
6. **Engine stalls when selecting gear**—Check vacuum hose between control valve and clutch servo. Check clutch servo for leaks. Replace both if necessary.
7. **Car jerks in idle when shifting into gear**—

Readjust idle speed. Check control valve adjustment (see Chapter Nine).

8. **Converter continually overheats**—This trouble usually means low converter line oil pressure or defective oil temperature sensing components. Check ATF level. Also check ATF oil pump on engine. Take the job to a dealer if the fluid level and pump are good, and the trouble persists.
9. **High pitched hissing from converter**—Check ATF level with dipstick. Check ATF pump on engine. Check torque converter stall speed as described below.
10. **Poor acceleration (engine output good)**—Normally caused by defective torque converter. Check stall speed as described below.
11. **Temperature warning lamp does not work**—The only way to tell when this circuit is defective is to test it. As suggested in Chapter Two, this is done every 6000 miles. If the lamp fails to light in either drive range, remove the wire from terminal K of the selector switch (see Chapter Nine, Figure 12) and ground the wire. If the lamp lights, replace the selector switch. If the lamp doesn't light, replace the lamp.

Torque Converter Stall Speed

This test permits rapid evaluation of the torque converter.

1. Connect an accurate tachometer to the engine. Start the engine, set the handbrake, and warm up the engine.
2. Depress the foot brake firmly, shift the lever to Drive 2.
3. Depress accelerator briefly to full throttle while holding the car at a complete stop with hand and foot brakes. Quickly read the engine speed reached on the tachometer.

CAUTION: *This is a severe test, and ATF in the torque converter heats very rapidly. Do not run the engine under full load any longer than necessary to read the tachometer (5-10 seconds).*

4. If the stall speed is more than 600 rpm below the specifications (2000-2250 rpm), the torque converter is defective and must be replaced. A stall speed only a few hundred rpm below specification indicates the engine is not delivering full

power and probably needs a tune-up. A stall speed higher than specified indicates clutch slippage.

BRAKES

1. **Brake pedal goes to floor**—There are numerous causes for this including excessively worn linings, air in the hydraulic system, leaky brake lines, leaky wheel cylinders, or leaky or worn master cylinder. Check for leaks and thin brake linings. Bleed and adjust the brakes. If this doesn't cure the trouble, rebuild wheel cylinders and/or master cylinder.

2. **Spongy pedal**—Normally caused by air in the system; bleed and adjust the brakes.

3. **Brakes pull**—Check brake adjustment. Also check for contaminated brake linings (from leaks), leaky wheel cylinders, loose calipers, frozen or seized pistons, and restricted brake lines or hoses. In addition, check front end alignment and suspension damage such as a broken front or rear torsion bar. Tires also affect braking; check tire pressures and condition. Replace or repair defective parts.

4. **Brake squeal or chatter**—Check brake lining thickness and brake drum roundness. Ensure that the shoes have chamfered ends and are not loose. Clean away all dirt on shoes and drums.

5. **Dragging brakes**—Check brake adjustment, including hand brake. Check for broken or weak shoe return springs, swollen rubber parts due to improper brake fluid or contamination, and obstructed master cylinder bypass port. Clean or replace defective parts.

6. **Hard pedal**—Check brake linings for contamination. Also check for restricted brake lines and hoses.

7. **High speed fade**—Check for distorted or out-of-round drums and contaminated brake linings. Ensure recommended brake fluid is installed. Drain entire system and refill if in doubt.

8. **Pulsating pedal**—Check for distorted or out-of-round brake drums. Check for excessive brake disc run out. Undetected accident damage is also a frequent cause of this.

STEERING & SUSPENSION

Trouble in the suspension or steering is evident when the following occur.

- a. steering is hard
- b. car pulls to one side
- c. car wanders or front wheels wobble
- d. steering has excessive play
- e. tire wear is abnormal

Unusual steering, pulling or wandering is usually caused by bent or otherwise misaligned suspension parts. This is difficult to check without proper alignment equipment. See Chapter Eleven for repairs which you can perform, and those that must be left to a dealer or front end specialist.

If your trouble seems to be excessive play, check wheel bearing adjustment first. This is the most frequent cause. Next check steering free play as described in Chapter Eleven. Then check king pins or ball joints as described below. Finally, check tie rod end ball joints by shaking each tie rod. Also check pitman arm nut and idler arm (Super Beetle only) nut for tightness.

Tire wear may be caused by suspension troubles, but may have many other causes. See Tire Wear Analysis in this chapter.

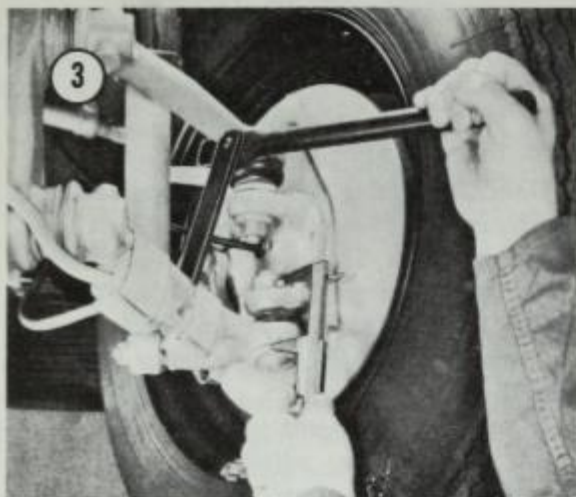
King Pin Suspension Play

1. Jack up one front wheel.
2. Hold the tire at the top with both hands. Shake the tire. If there is any play in this direction, it may be in the wheel bearings, torsion arm link pins, king pin, or a combination of all.
3. Hold the tire at the front and rear edge. Push and pull the tire horizontally. Any play is in the wheel bearings, steering gear, pitman arm, tie rods or a combination of all.

Ball Joint Suspension Play

Play in the ball joint suspension is difficult to feel using the king pin suspension method since the torsion arms load the ball joints slightly. Volkswagen uses a special tool as shown in **Figure 3** to pry the torsion arms apart. Any movement between the torsion bars must occur as a result of ball joint play. The tool is well illustrated and is not difficult or expensive to make. To check play:

1. Raise the front of the car on jackstands.
2. Place lever between torsion arms as shown in Figure 3.
3. Place vernier caliper in position shown in the figure.



4. Work the torsion arms apart and measure the movement on the caliper. Ball joint wear limits are .040" bottom; .080" top.

Super Beetle Strut Suspension

Volkswagen uses a special tool which compresses and releases the ball joint to measure axial play. This tool is more difficult to make than the one for the ball joint suspension. The following method does not require special tools:

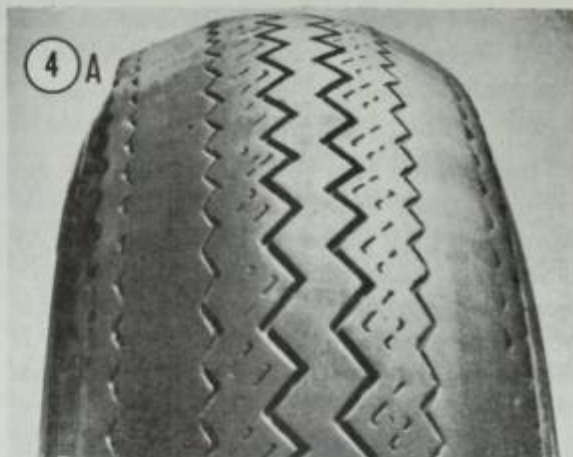
1. Jack the front of the car up on jackstands so the bottom of the tires is 1-2" off the ground.
2. Have an assistant stick a tire iron under the tire and pry up on it. This relieves the load on the ball joint.
3. From under the car place a vernier caliper between the track control arm and the steering knuckle.
4. Shake the wheel end of the track control arm up and down. Measure the movement with the caliper. Replace the ball joint if movement (play) exceeds 0.12" (3mm).

TIRE WEAR ANALYSIS

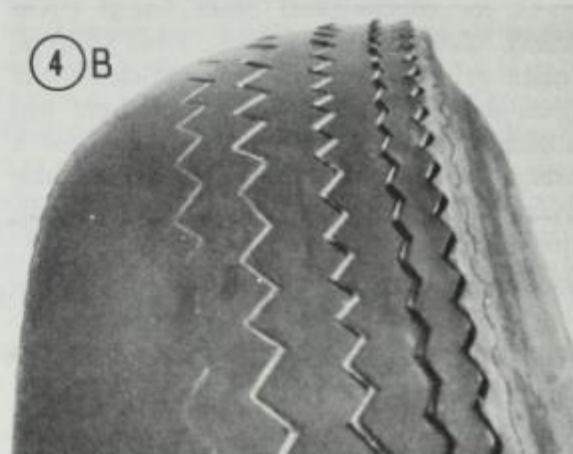
Abnormal tire wear should always be analyzed to determine its causes. The most common causes are:

- a. incorrect tire pressure
- b. improper driving
- c. overloading
- d. bad road surfaces
- e. incorrect wheel alignment

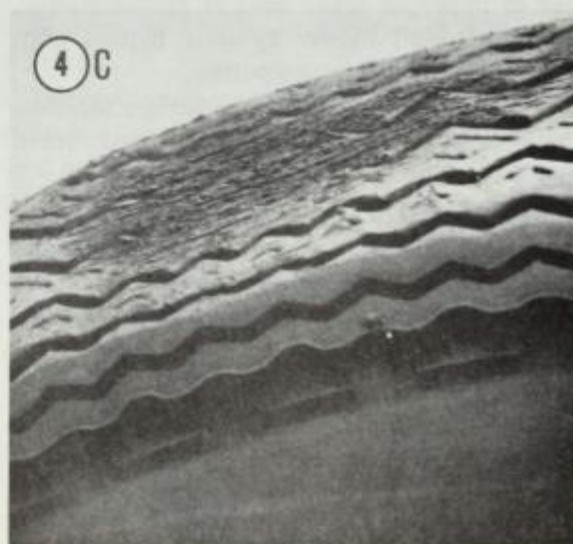
Figures 4A to 4F identify wear patterns and indicate the most probable causes.



Underinflation—Worn more on sides than in center.



Wheel Alignment—Worn more on one side than the other. Edges of tread feathered.



Road Abrasion—Rough wear on entire tire or in patches.



Overinflation—Worn more in center than on sides.



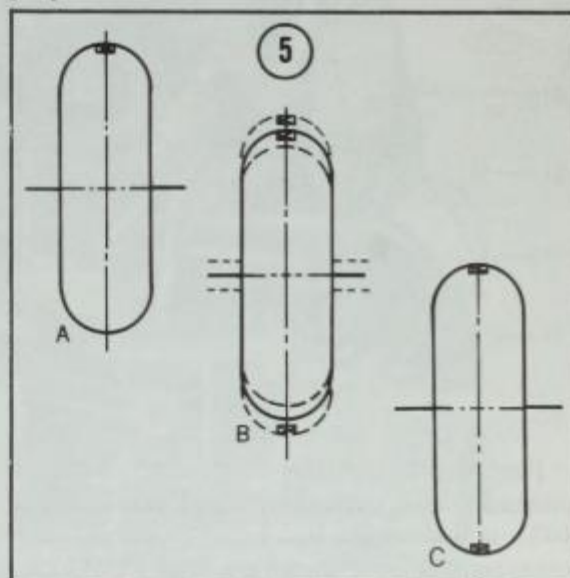
Wheel Balance—Scalloped edges indicate wheel wobble or tramp due to wheel unbalance.



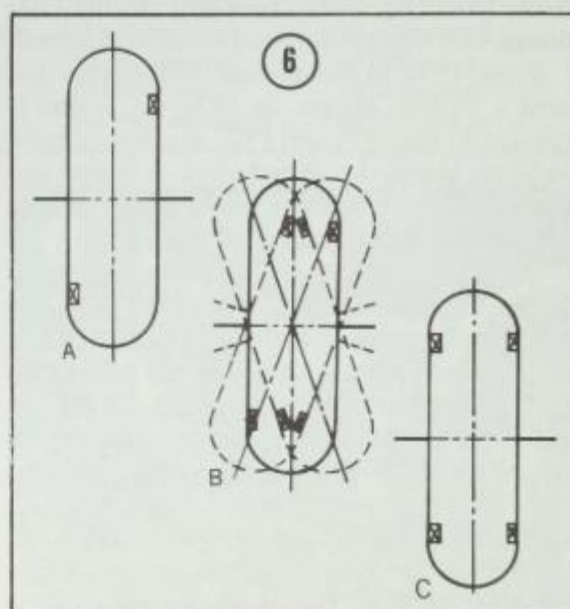
Combination—Most tires exhibit a combination of the above. This tire was overinflated (center worn) and the toe-in was incorrect (feathering). The driver cornered hard at high speed (feathering, rounded shoulders) and braked rapidly (worn spots). The scaly roughness indicates a rough road surface.

WHEEL BALANCING

All 4 wheels and tires must be in balance along 2 axes. To be in static balance, weight must be evenly distributed around the axis of rotation. **Figure 5 (a)** shows a statically unbalanced wheel. **Figure 5 (b)** shows the result—wheel tramp or hopping. **Figure 5 (c)** shows proper static balance.



To be in dynamic balance, the centerline of the weight must coincide with the centerline of the wheel. **Figure 6 (a)** shows a dynamically unbalanced wheel. **Figure 6 (b)** shows the result—wheel wobble or shimmy. **Figure 6 (c)** shows proper dynamic balance.



CHAPTER FOUR

ENGINE

Four versions of the 4 cylinder, air-cooled overhead valve engine were used from 1961 to 1971. All 4 engines are similar in design, varying mainly in their specifications (see Pages 70-73). From 1961 to 1965, Volkswagen used a 40 hp, 1200cc engine. In 1966, the company introduced a 50 hp, 1300cc engine which required a new crankshaft, cylinders, heads, and crankcase with replaceable camshaft bearing shells. The 53 hp, 1500cc engine powered the Beetle from 1967-1969 and is basically the 1300 design with a larger bore and modified flywheel.

From 1970 to the present Volkswagen has used a 1600cc engine. In 1970 the engine is rated at 57 hp; 1971 and 1972 engines are rated at 60 hp, largely due to carburetion changes and new dual port cylinder heads. **Figures 1A and 1B** show cut-away views of a typical engine.

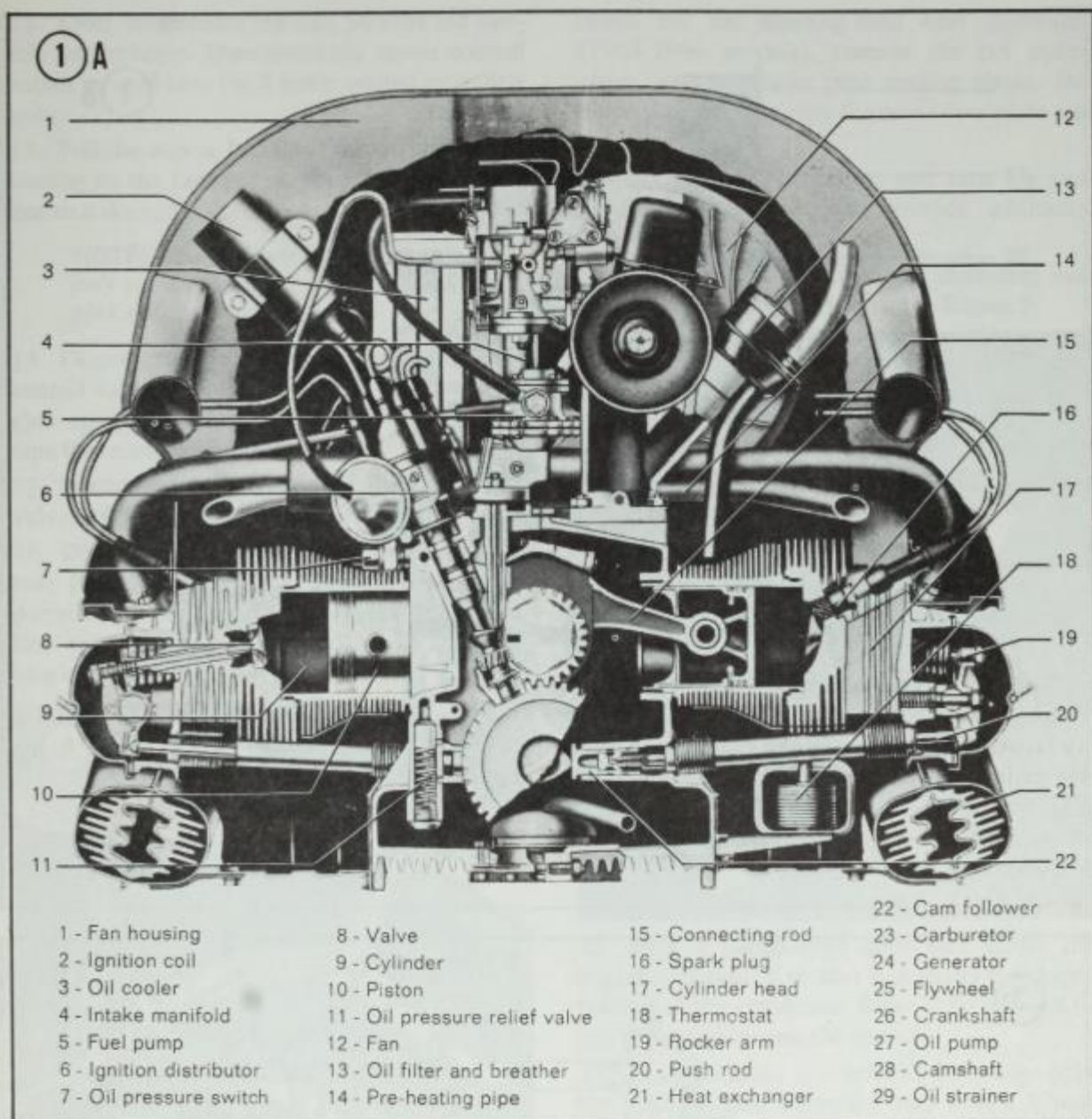
Volkswagen frequently makes minor engine design changes during a production run. For this reason, **always** order engine parts by year, chassis number, and engine number. Never substitute engine parts from one engine in another unless the parts are obviously identical or you have experience with that particular substitution. Design changes are often very subtle, and incorrect substitutions can be disastrous.

This chapter includes repair procedures for the 1200, 1300, 1500, and 1600cc engines. Few

repairs other than fuel and ignition system troubles are possible with the engine installed. If in doubt, refer to the procedure in question to determine if the engine must be removed.

ENGINE REMOVAL

1. Prop the engine compartment lid up, or remove it.
2. Drain engine oil.
3. Put the transmission in neutral and chock the front tires.
4. Disconnect ground strap from the battery.
5. Remove air cleaner.
 - 6a. On 1961-1966 voltage regulators, mounted on the generator, disconnect the small wire and mark it 61. Disconnect the large wire (or wires) and mark it B+51. Disconnect and mark ignition coil wires.
 - 6b. On 1967-1972 models, disconnect 3 wires from the generator. Mark them in accord with the labels stamped on the generator. Disconnect and mark ignition coil wires.
7. Disconnect electrical wire for the automatic choke on the right side of the carburetor and mark it 01. Disconnect wire from electromagnetic cut-off jet near the choke and mark it 02.
8. Disconnect the oil pressure switch wire located on the crankcase under the distributor.

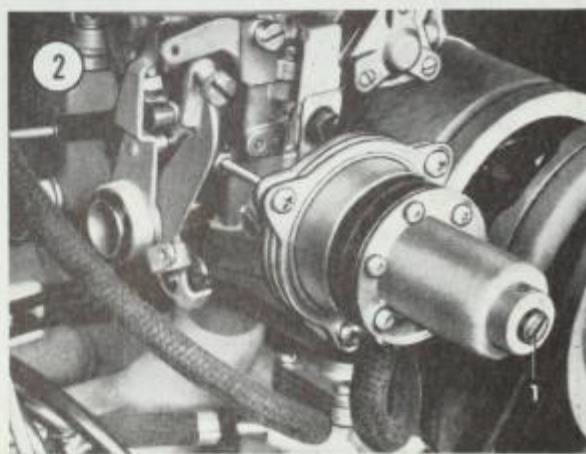


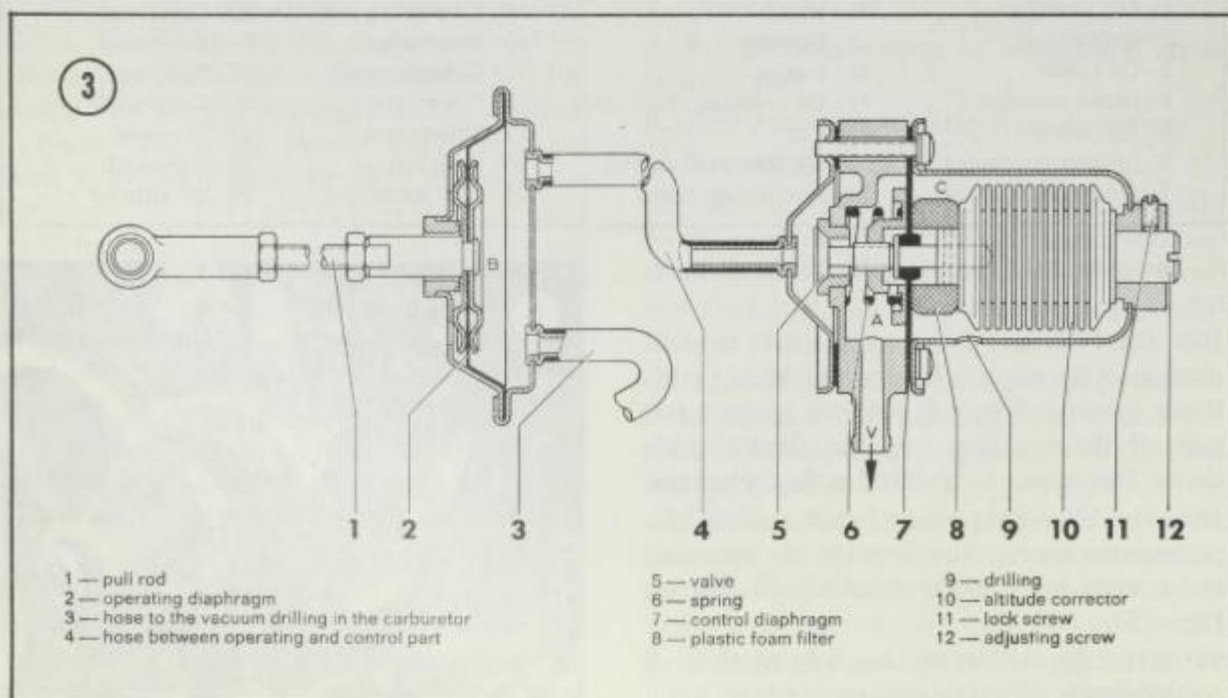
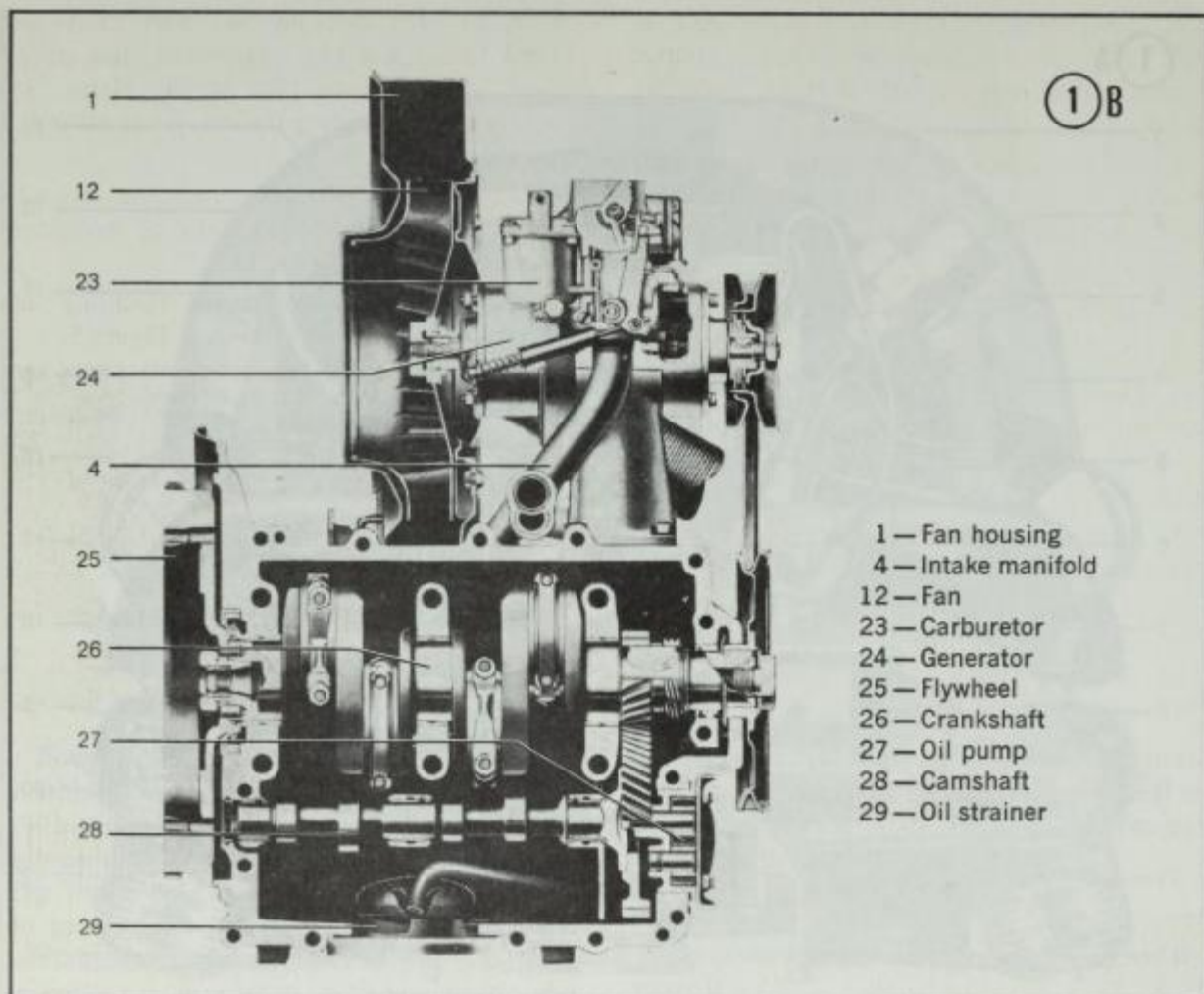
9. Disconnect the throttle cable to the carburetor.

10a. On 1968 and 1969 manual shift models, disconnect the vacuum hose on the throttle positioner shown in **Figure 2**. Remove 3 screws and pull off the retaining ring and throttle positioner. Disconnect the pull rod at the carburetor.

10b. On 1970-1972 manual shift models, disconnect the vacuum line between the operating and control parts of the throttle positioner (4, **Figure 3**).

11. Raise the rear of the car, and block it up on jackstands.





12. From underneath the car, pull off the flexible heater hoses. Disconnect the heater control cables located near the 2 lower engine mounting bolts.

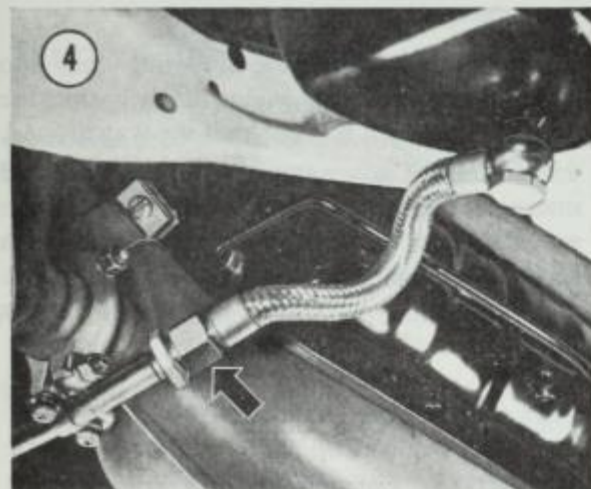
13. Pull the woven fuel line off the copper tube leading to the fuel pump. Plug the woven fuel line so it doesn't leak.

NOTE: The following 5 steps apply only to cars equipped with automatic stick shift.

14. Disconnect the electrical wires from the control valve mounted on the left side of the engine compartment. Mark them with masking tape for reconnection later.

15. Disconnect 2 vacuum lines for the control valve from the carburetor and intake manifold.

16. Disconnect the line between the fluid reservoir (under the right rear fender) and the oil pump at the union nut. See **Figure 4**. Seal the line with a spare union nut which has been blocked with solder.



17. Disconnect the oil pressure line between the oil pump and the torque converter at the union nut. Position the line so it doesn't leak.

18. Remove screws securing the torque converter to the drive plate. Hand-turn the engine with the fan belt until each screw is accessible through one of the transmission case openings, then remove the screw.

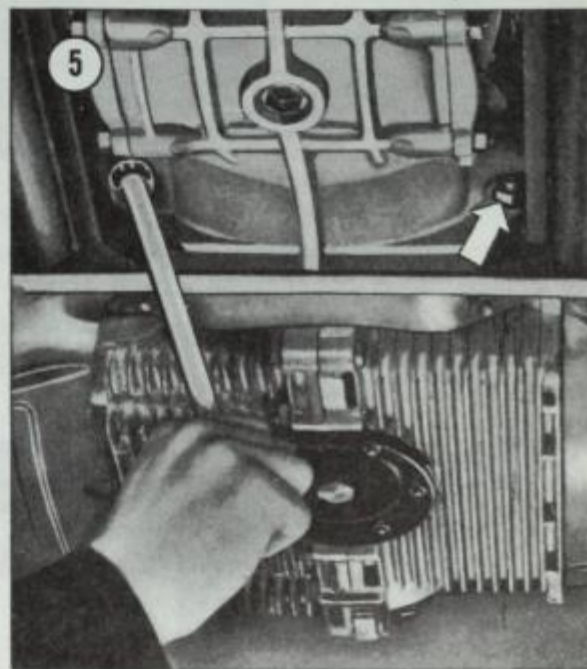
NOTE: Remaining steps apply to all models unless specified otherwise.

19. On 1961-1966 models, remove the rear cover plate. To do this, disconnect the hoses be-

tween the fan housing and heat exchanger (1963-1966 models), remove the fan pulley cover, and preheater pipe sealing plates. Remove 6 screws securing the rear cover plate and then the plate.

20. Loosen the distributor, and turn the vacuum advance inward to provide additional clearance.

21. Remove both lower engine mounting nuts with a 17mm wrench as shown in **Figure 5**.

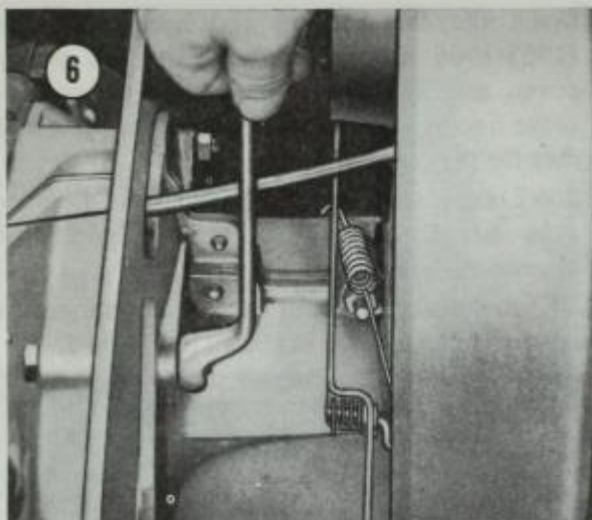


22. Slide a garage-type floor jack under the engine and raise it so that it contacts the center bottom of the crankcase. Raise it far enough to put slight pressure on the engine.

23. If an assistant is available, have him hold the upper engine mounting nuts with a 17mm box wrench while you unscrew the bolt from underneath the car. See **Figure 6**. The nuts are accessible by reaching behind the fan shroud; you'll have to feel around for them as they are not visible. If an assistant is not available, hold the nut with vise grips, wedged so the nut cannot turn.

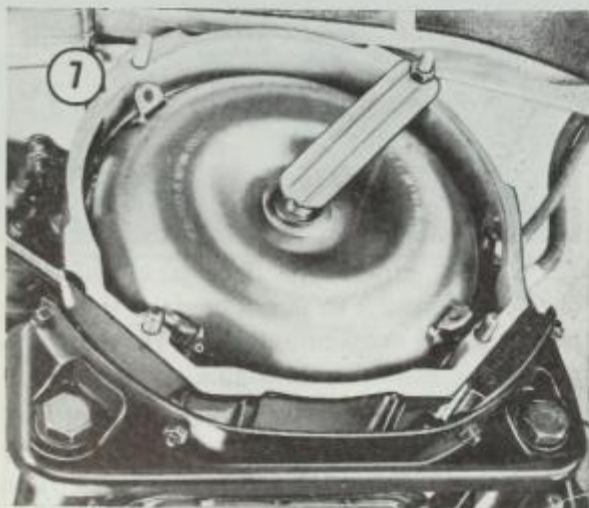
24. Roll the engine **straight** backwards until the clutch release plate clears the main drive shaft.

CAUTION: Do not let the engine tilt or let engine weight put any load on the drive shaft. Either the drive shaft or clutch parts can be seriously damaged.



25. Lower the engine slowly, making sure the clutch release plate remains clear of the drive shaft until the engine can be withdrawn.

26. If the car is equipped with the Automatic Stick Shift, secure the torque converter with a retainer plate as shown in **Figure 7**.



ENGINE INSTALLATION

1. Clean the transmission case and engine flange thoroughly.
2. On automatic stick shift cars, remove the temporary retaining strap installed during removal.
3. On manual shift cars, make sure the clutch plate is properly centered (see Chapter Eight). Inspect the clutch release bearing and release plate for wear and cracks. Replace them if necessary.

4. Lubricate the starter shaft bushing with universal bearing grease. Put $\frac{1}{3}$ oz. of universal grease in the gland nut.

5. Apply molybdenum disulphide powder or heavy duty grease to the main drive shaft spline and the plastic ring on the clutch release bearing. Use a clean cloth or a brush.

6. Put the transmission in gear to steady the main drive shaft.

7. Lift the engine into place with a garage-type floor jack.

8. Rotate the engine crankshaft with the fan belt so that the clutch plate hub lines up with the main drive shaft splines. Take care that the gland nut needle bearing, clutch release bearing, and main drive shaft are not damaged when pushing the engine forward.

CAUTION: *Do not let the engine tilt or let engine weight put any load on the drive shaft. Either the drive shaft or the clutch parts can be seriously damaged.*

9. Guide the lower engine mounting studs into position, then push the engine firmly against the transmission until it is flush all the way around.

10. Install the upper engine mounting bolts and nuts and tighten slightly. Install the lower mounting nuts and tighten slightly. Then tighten all bolts and nuts. Pull the floor jack out.

11. Install the rear cover plate on 1961-1966 models.

12. Reconnect the woven fuel line to the copper line leading to the fuel pump.

NOTE: *The following 3 steps apply only to automatic stick shift cars.*

13. Install 4 screws which secure the torque converter to the drive plate. Tighten them to 22 foot-pounds. Be careful not to drop any screws into the transmission case. The engine must be removed to get them out.

14. Reconnect the oil pressure line for the torque converter and the oil suction line for the fluid reservoir.

15. Reconnect the vacuum lines for the control valve to the carburetor and intake manifold. Reconnect the electrical wires to the control valve.

NOTE: Remaining steps apply to all models unless otherwise specified.

16. Reconnect the flexible heater hoses and heater control cables.
17. Install the throttle positioner (1968 & 1969 manual shift cars only) and reconnect its vacuum line. On 1970-1972 manual shift cars, simply reconnect the vacuum line between the control and operating units.
18. Reconnect the electrical wires for the oil pressure switch, electromagnetic cut-off jet, automatic choke, generator, and ignition coil.
19. Reconnect the accelerator cable and adjust it (see Chapter Six).
20. Install air cleaner.
21. Adjust clutch free-play (Chapter Eight).
22. Add 2½ quarters of engine oil.
23. Check the transmission fluid level in automatic stick shift cars and top up if necessary.
24. Reconnect the battery ground strap.

ENGINE DISASSEMBLY / ASSEMBLY

The following sequences are designed so that the engine need not be disassembled any further than necessary. Unless otherwise indicated, procedures for major assemblies in these sequences are included in this chapter. The procedures are arranged in the approximate order in which they are performed.

To perform a step, turn to the procedure for the major assembly indicated, e.g., cylinder head, and perform the removal and inspection procedures. Move to the next step, perform the removal and inspection procedures, etc. until the engine is disassembled. To reassemble, reverse the disassembly sequence and perform the installation procedure for the major assembly involved.

Decarbonizing or Valve Service

1. Remove cover plates and fan housing.
2. Remove valve rocker assemblies.
3. Remove cylinder heads.
4. Remove and inspect valves, guides, and seats.
5. Assembly is the reverse of these steps.

Valve and Ring Service

1. Perform steps 1-4 for valve service.
2. Remove cylinders.
3. Remove rings. It is not necessary to remove the pistons unless they are damaged.
4. Assembly is the reverse of these steps.

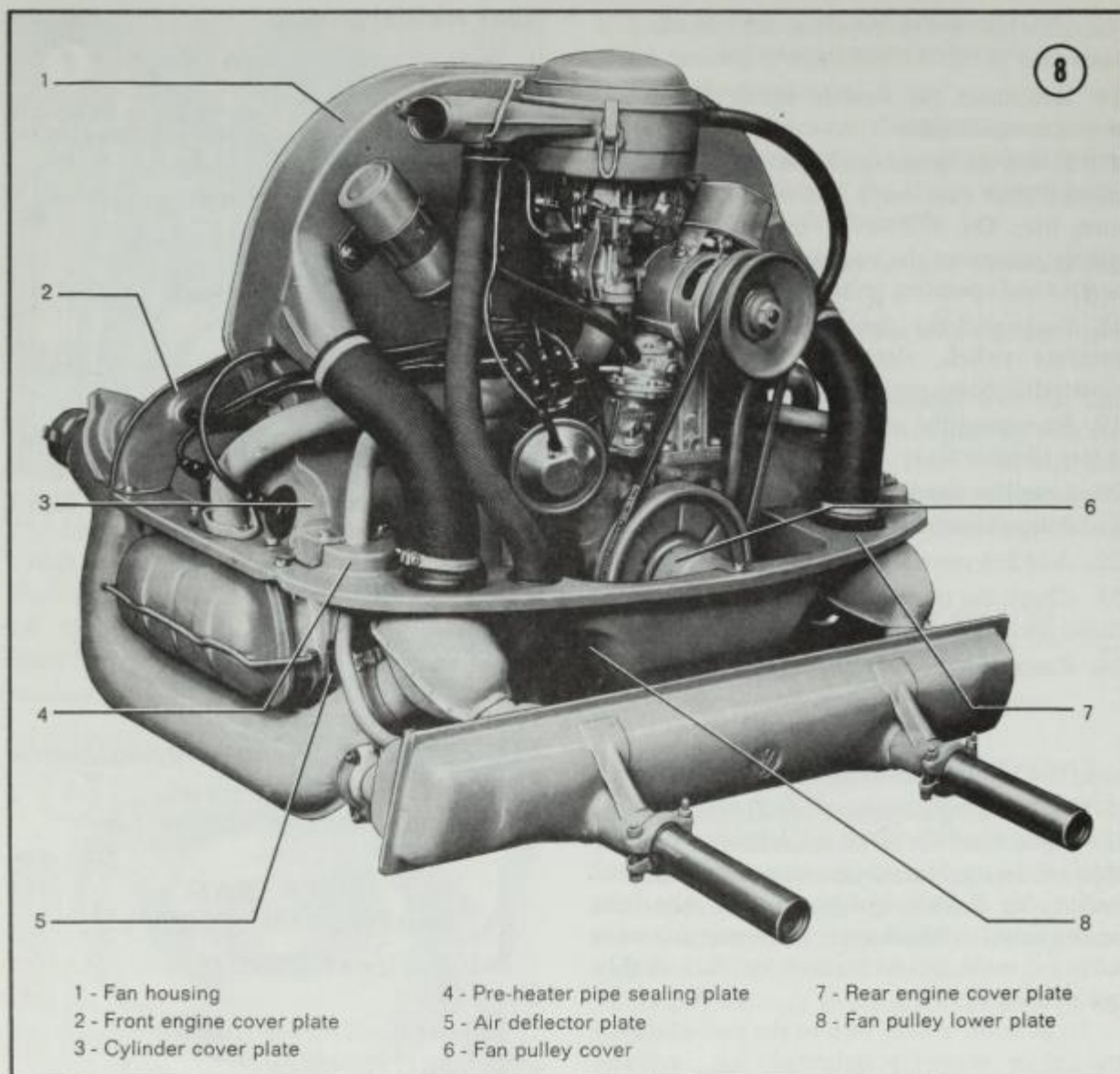
General Overhaul Sequence

1. Remove cover plates and fan housing.
2. Remove oil cooler.
3. Remove muffler and heater assemblies (Chapter Five).
4. Remove distributor (Chapter Seven), fuel pump (Chapter Six), and distributor drive gear.
5. Remove clutch assembly (Chapter Eight) and flywheel.
6. Remove valve rocker assemblies.
7. Remove cylinder heads.
8. Remove cylinders and pistons.
9. Remove oil pump and oil strainer.
10. Disassemble crankcase.
11. Remove camshaft, crankshaft, and connecting rods.
12. Assembly is the reverse of these steps.

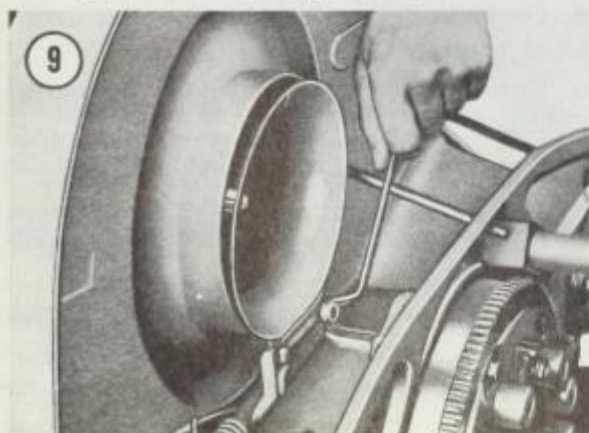
COVER PLATE DISASSEMBLY / ASSEMBLY

Refer to **Figure 8** to identify cover plates discussed below.

1. Remove hoses between fan housing and heat exchangers (1963-1972).
2. Remove front engine cover plate (2).
3. Remove fan pulley cover (4).
4. Remove pre-heater pipe sealing plates (6).
5. On 1966-1972 models, remove rear engine cover plate (3).
6. Remove intake manifold with carburetor attached.
7. Loosen generator pulley nut and remove the fan belt.
8. Disconnect the wire from the ignition coil to the distributor. Mark it 15.
9. Remove distributor cap and pull spark plug connectors off.
10. Remove screws on both sides of the fan housing.



11a. On 1961-1964 models, unhook the air control ring spring and remove bolts securing the ring to the fan housing. See **Figure 9**.



11b. On 1965-1972 models, remove the air control thermostat screw (see **Figure 10**) and unscrew the thermostat from the control rod.

12. Pull the fan housing straight up complete with generator.

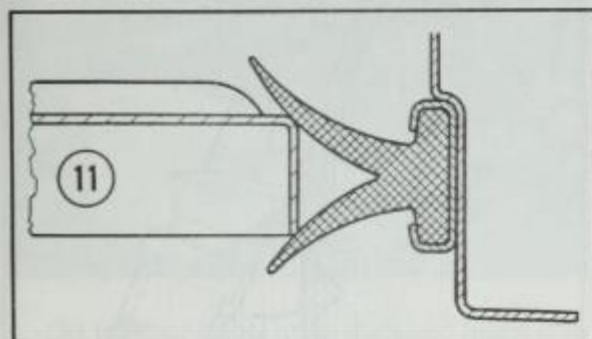
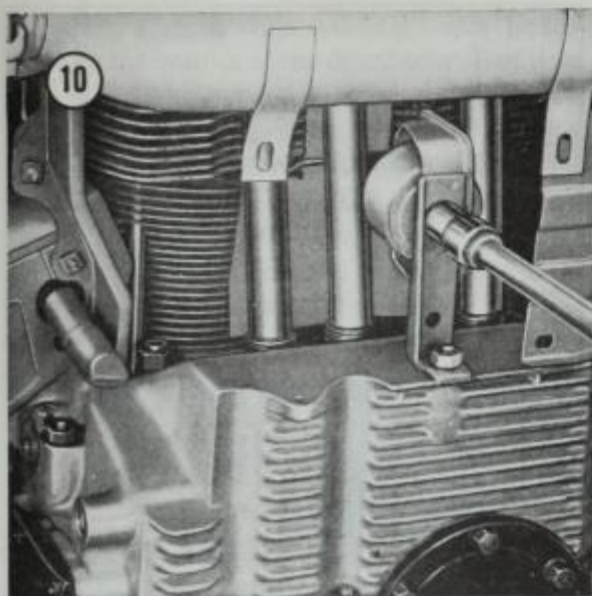
13. Remove rear air deflector plate (7), and the lower air ducts (not shown).

14. Lift cylinder plates (8) off.

15. Remove crankshaft pulley.

16. Remove lower crankshaft pulley plate (5).

17. Assembly is the reverse of these steps. Refer to Chapter Five for air control thermostat adjustment (all models) after reassembly. Ensure that any weather stripping fits over and under mating cover plates. See **Figure 11**.



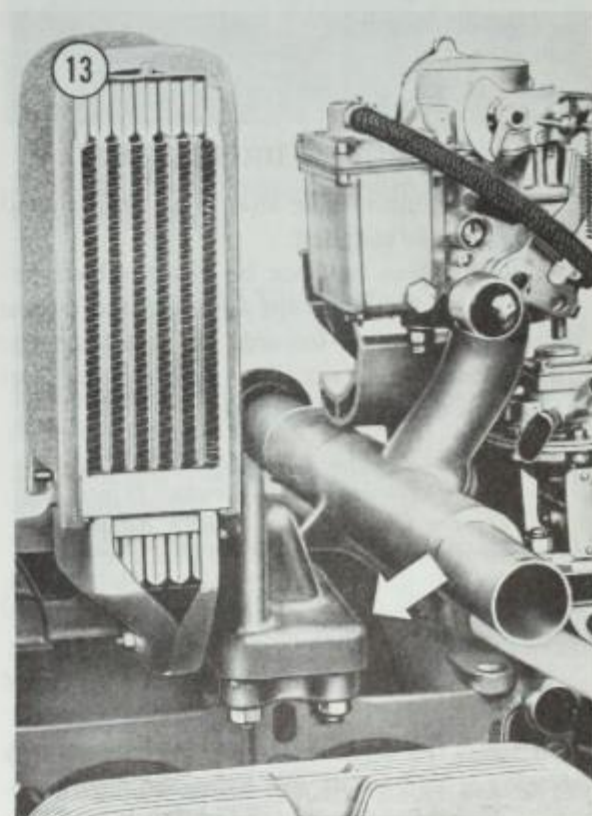
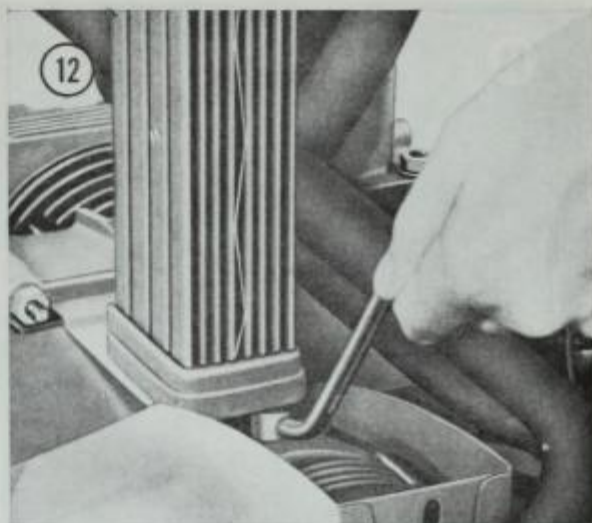
OIL COOLER

The oil cooler can be replaced with the engine installed. If the engine is in the car, remove the fan housing following the procedure in Chapter Five. If the oil cooler has been leaking, check the oil pressure relief valve(s) for damage causing high oil pressure. Bulging cores are a sign of pressure damage. The distortion, in turn, can restrict air flow and lead to engine overheating. Replace cooler.

If non-detergent oil has been used, and you wish to change to detergent oil, discard the old oil cooler and install a new one. Otherwise particles in the old cooler will work loose and could clog a vital oil passage.

Removal

1. Remove the oil cooler retaining nuts. If the engine is in the car, use an offset wrench as shown in **Figure 12** for 1961-1970 oil coolers. On 1971 and 1972 oil coolers, all nuts are on the front of the cooler (see **Figure 13**).



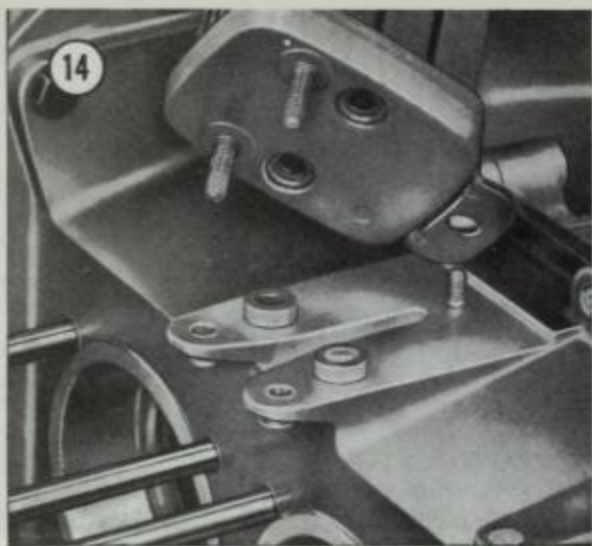
2. Pull the oil cooler off and remove the rubber seals. See **Figure 14**.

3. Pour solvent in the cooler and let it soak upside down. Pour the solvent out and flush with clean solvent.

4. Check that no ribs touch each other, and that no parts are loose.

Installation

1. Install new seals on the bracket.



2. Install the oil cooler and nuts. Tighten all nuts evenly. The oil cooler must be vertical, not leaning to one side.

DISTRIBUTOR DRIVE SHAFT

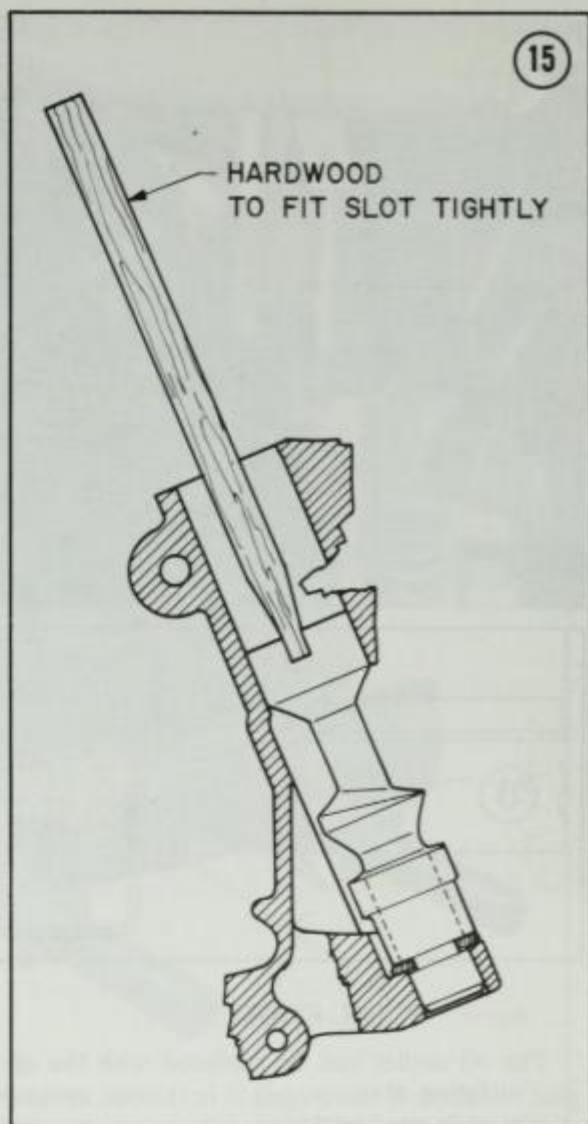
The distributor drive shaft may be removed with the engine installed.

1. If the engine will not be disassembled, remove the distributor cap, and turn the engine so the rotor points towards the notch on the distributor housing rim. This puts piston #1 at TDC of its compression stroke.

NOTE: Do not turn the engine over after removing the distributor. If you do, see Chapter Two (Valve Adjustment) to re-set piston #1 to TDC.

2. Remove the distributor (see Chapter Seven) and fuel pump (see Chapter Six).
3. Remove the spring on top of the distributor drive shaft.
4. Extract the drive shaft with a special tool by rotating it to the left and lifting up simultaneously. One method which works well is shown in Figure 15.
5. Reach down in the crankcase through the distributor drive shaft hole with a magnet, and lift out the thrust washer(s).

CAUTION: Do not drop the washers into the crankcase if you do not intend to disassemble the crankcase. Occasionally it is possible to fish them out if dropped; usually it means splitting the crankcase.



Inspection

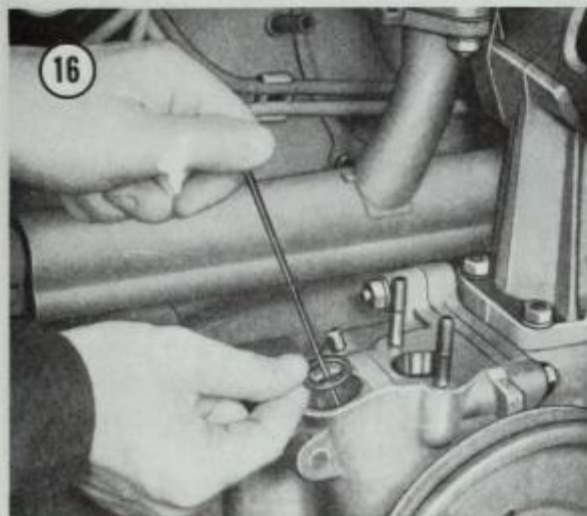
Check the distributor drive gear and fuel pump eccentric for wear. If the distributor drive gear is worn, you should also check the crankshaft gear. This means completely disassembling the engine.

Installation

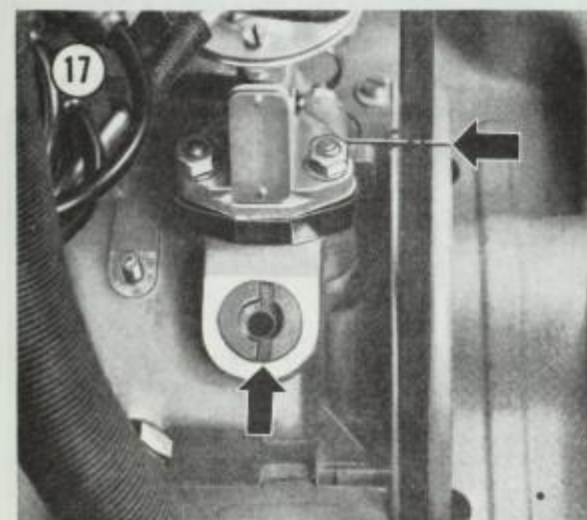
This procedure should be performed after the engine is completely assembled, with the exception of the distributor and fuel pump.

1. Ensure that piston #1 is at TDC on the compression stroke. If you have not disassembled the engine, or turned the engine over since distributor removal, it should be correct. Otherwise, see Chapter Two (Valve Adjustment) to set piston #1 correctly.

2. Insert a small wire rod (e.g., coat hanger wire) to the bottom of the distributor shaft hole.
3. Apply universal grease to the thrust washer(s), and slide them down the wire rod (see **Figure 16**). Do not move the rod until the washers are in place; the rod keeps the washers from dropping into the crankcase. Look into the hole and check that the washers are all the way down and centered, then remove the rod. Grease holds the washers in place.

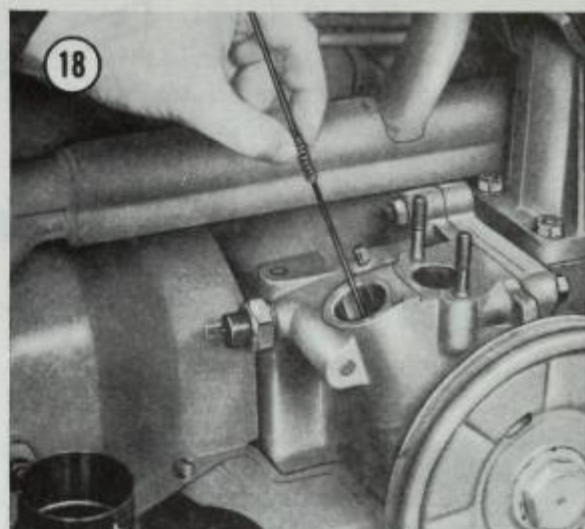


4. Oil the distributor drive shaft and insert it so the slot is perpendicular to the crankcase seam. See **Figure 17**. Push the shaft down with a large screwdriver until you are certain it is seated in the thrust washers.



5. Turn the crankshaft by hand and watch the distributor drive shaft. If the shaft turns, it is seated properly.

6. Insert the wire rod into the hole in the distributor drive shaft. Slide the small spring over the rod into the shaft. See **Figure 18**. Remove the rod.



7. Install the fuel pump and distributor (see respective chapters).

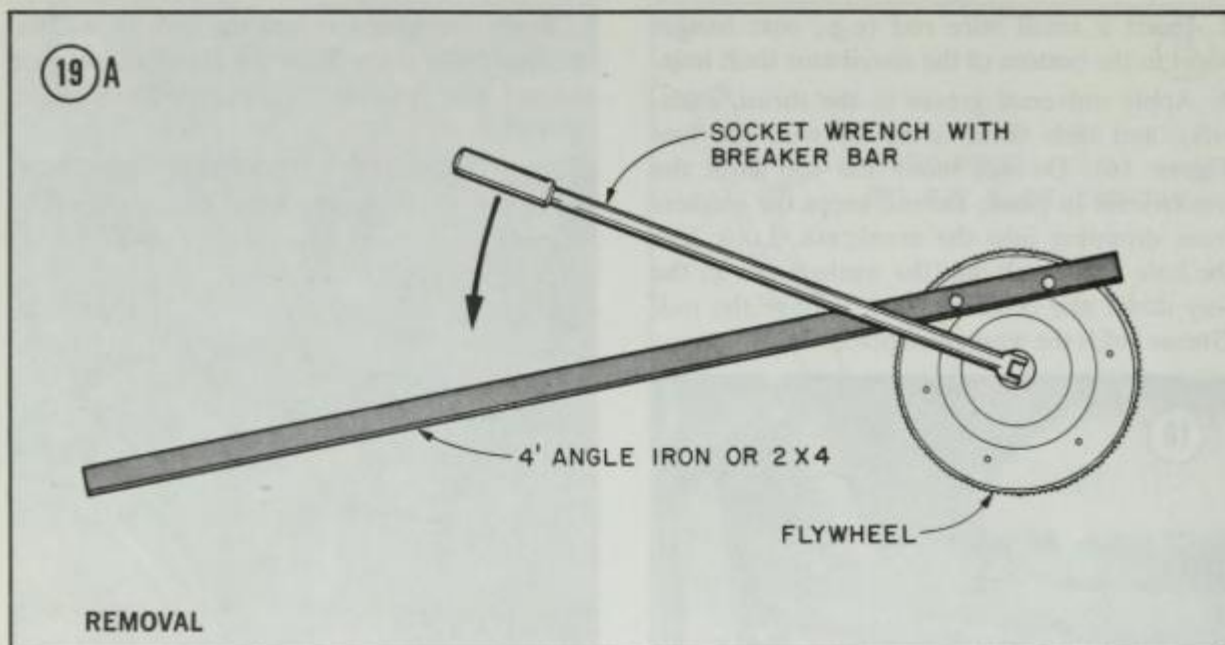
FLYWHEEL

Removal

1. Remove the clutch pressure plate and drive plate. See Chapter Eight.
2. Mark the relationship between the flywheel and crankshaft.
3. Hold the flywheel in a special retainer, remove the gland nut and spring washer. It is torqued to 217 foot-pounds so a wrench with breaker bar is necessary. If a special flywheel retainer is not obtainable, bolt a 3-4 foot angle iron or 2x4 between 2 clutch bolt holes on the flywheel as shown in **Figure 19A**.
4. Pull the flywheel off. Don't lose any of the metal dowels on the end of the crankshaft.

Inspection

1. Check the dowel holes in the flywheel and crankshaft. If they are out-of-round, have new holes drilled in a different spot.
2. Check the dowels. Replace them if marred.
3. Check the flywheel teeth for wear or damage. If the teeth are damaged only slightly, up to 0.08" may be machined off the clutch side. Re-chamfer the edges of the teeth.



4. Check the gland nut bearing for wear. Replace if necessary.

5. Remove the paper or metal gasket and note which you have, so a proper replacement can be made. No gasket is used on 1966 (from Engine # FO 741385) to 1972 flywheels; a rubber seal is used instead.

Installation

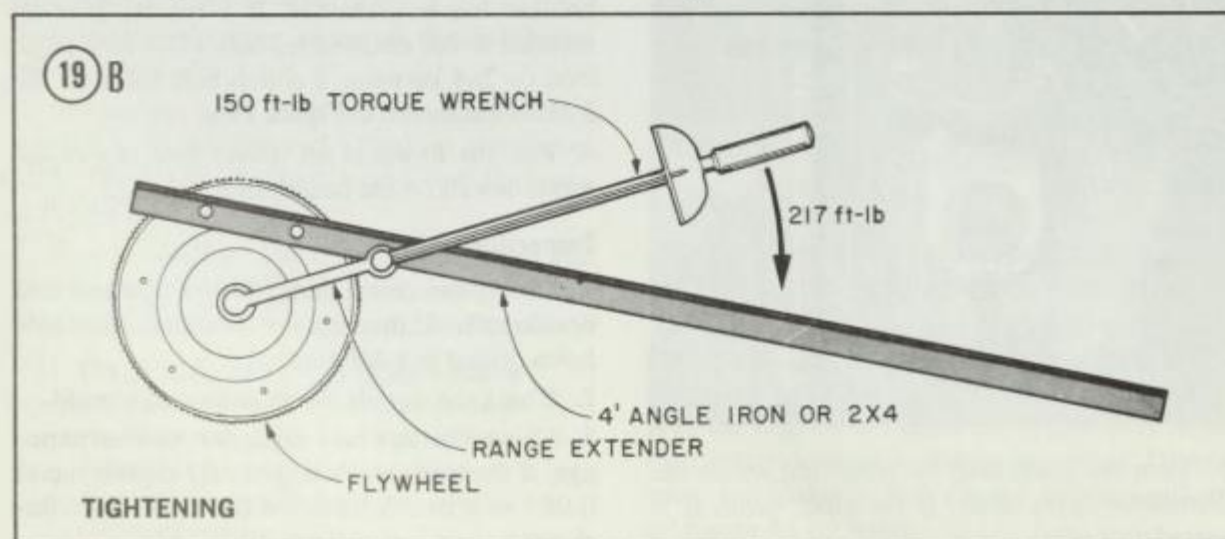
1. Lubricate the outer surfaces of the front crankcase oil seal.

2. Reinstall the flywheel on the crankshaft using all 4 dowels, and a new paper or metal gasket, depending on the type removed above. If the crankshaft, flywheel, or clutch is new, note that

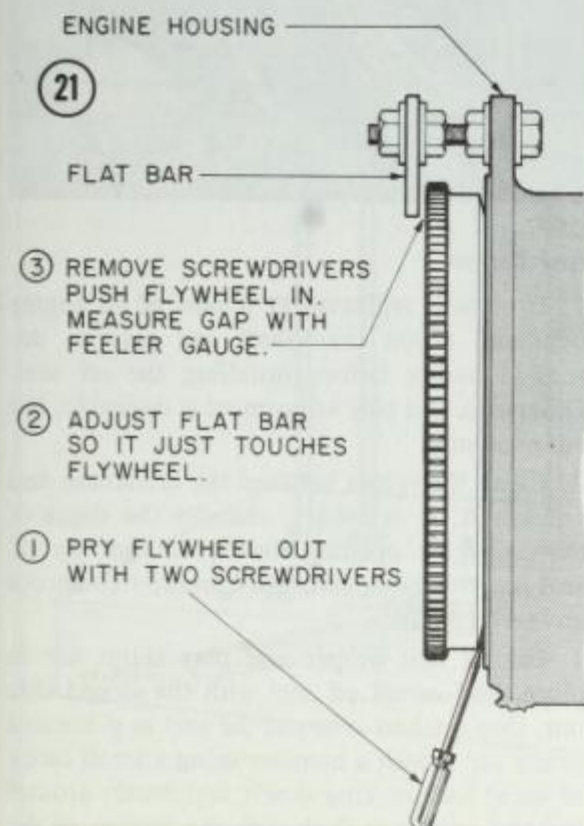
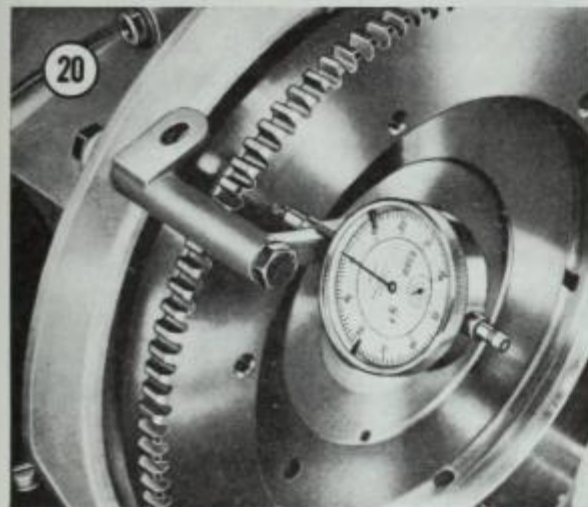
the heaviest points are marked. The crankshaft is marked with a spot of paint and a 5mm hole on the flywheel end. The flywheel and clutch may be marked with a painted line on the outer edge. If all 3 parts have a mark, install them so the marks are distributed 120° from each other. If only 2 have a mark, install them so the marks are 180° from each other.

3. Install the gland nut and tighten to 217 foot-pounds. Use the 2x4 or angle iron to keep the flywheel from rotating when tightening. See **Figure 19B**.

4. Check crankcase end play using a procedure applicable to your engine (see Crankshaft End Play).



5. Check flywheel run-out. The easiest method is to attach a dial indicator as shown in **Figure 20**, rotate the flywheel, and note the reading variation or run-out. A more tedious method requires the threaded stock and flat bar used for end play measurement (see **Figure 21**). Set the bar 0.012" from the face of the flywheel. Mark off the rim of the flywheel in about 6 equal segments. Rotate the flywheel so each segment is near the flat bar and measure the gap. When all

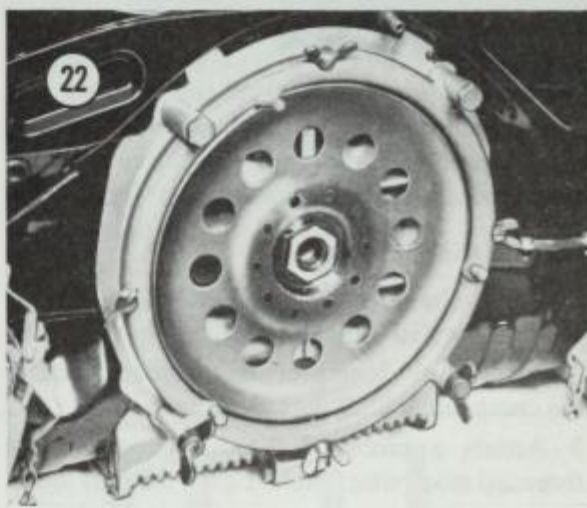


6 gaps are recorded, determine that no 2 gaps are more than 0.012" apart. If they are, the flywheel must be machined true or replaced.

DRIVE PLATE

The drive plate for the automatic stick shift is attached to the crankshaft with a gland nut in the same manner as the flywheel.

A special retaining ring shown in **Figure 22** is required to hold the drive plate while removing the gland nut. The nut is torqued to 282 foot-pounds (39 mkg). Rather than improvise a ring and risk warping the drive plate, take the entire engine to a VW dealer and let him remove it. Later when the engine is reassembled, let VW reinstall the drive plate.



CRANKSHAFT END PLAY

Crankshaft end play must be adjusted any time the engine is completely disassembled, and should be checked any time the engine is removed for whatever purpose.

Two methods are used to check end play. By far the easiest is the dial indicator method. But dial indicators are expensive. Those who do not wish to purchase one may use the second method.

With Dial Indicator

1a. On 1961-1966 (up to Engine # FO 741 384) engines, install the flywheel with 2 shims and a new paper or metal gasket. The paper gasket compresses to about 0.006"; the metal gasket to about 0.019". Do not install the front oil seal.

1b. On late 1966 (FO 741 385 — on) to 1972 engines, install the flywheel with 2 shims, but without the rubber seal.

2. Attach a dial indicator as shown in Figure 20.

3. Move the crankshaft back and forth. Read the end play on the dial indicator. Record this figure.

4. Calculate the thickness of the 3rd shim by subtracting the desired end play (see specifications for your engine) from the figure recorded in the previous step.

5. Remove the flywheel, install a 3rd shim as calculated above, and reinstall the flywheel. On 1961-1966 engines, reuse the paper or metal gasket. On later 1966-1972 engines, use a new rubber seal.

6. Remeasure the end play. If it is correct, remove the flywheel and install the front oil seal (see procedure later in this chapter). Reinstall the flywheel. If end play is not correct, change one of the shims and remeasure.

Without Dial Indicator

1. Install the flywheel as described in step 1a or 1b of the dial indicator method above.

2. Attach a 5" length of $\frac{3}{8}$ threaded stock to the crankcase with 2 nuts. See Figure 21.

3. Attach a piece of flat bar stock to the threaded stock with 2 nuts. Leave the nuts loose.

4. With a large screwdriver, carefully pry between the flywheel and crankcase to move the crankshaft all the way forward. Have someone hold the screwdriver in this position.

5. Adjust the flat bar stock on the threaded rod until it just touches the surface of the flywheel. Tighten the nuts in this position.

6. Remove the screwdriver and push the flywheel back.

7. Insert a feeler gauge between the flat bar stock and the flywheel. This is end play; record this figure.

8. Calculate the thickness of the 3rd shim and install it and the flywheel as described in steps 4-6 of the dial indicator method.

FRONT OIL SEAL

The oil seal normally leaks a small amount of oil which lubricates the seal lips and prevents

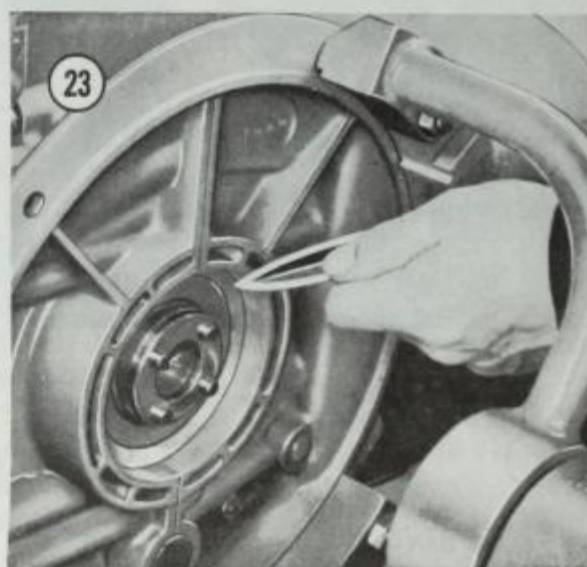
them from burning. This leaking causes a thin smear of oil to coat the transmission case. This smear does not indicate a defective seal. Replace the seal if leaking appears excessive or if the seal is removed for any reason; never reuse a seal.

Removal

1. Remove flywheel using the procedure given previously.

2. Carefully pry the old seal out with a screw driver or other sharp object. See Figure 23. Don't nick the crankcase surface. Discard the oil seal.

3. Leave all end play shims in the crankcase.



Installation

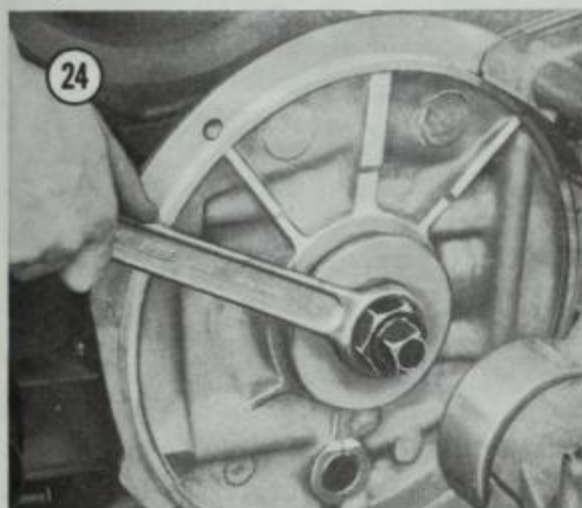
1. If oil seal replacement is part of an engine overhaul, adjust crankshaft end play as described earlier before installing the oil seal. Otherwise, end play adjustment is desirable, but not necessary.

2. Clean the recess between the crankcase and crankshaft. If necessary, chamfer the edges of the crankcase opening slightly so that the oil seal seats without damage. Carefully clean out any metal flakes.

3. Ensure that proper end play shims are in place, and install oil seal with the closed side out. One method is to put the seal in place and gently tap it with a hammer using a small block of wood and working slowly and evenly around the seal until it is flush with the bottom of the

crankcase recess. Another method requires a special tool shown in **Figure 24**, which presses the seal in evenly. This is easily improvised with a metal plate, large nut and bolt to fit the hole in the end of the crankshaft.

4. Reinstall the flywheel as described previously.



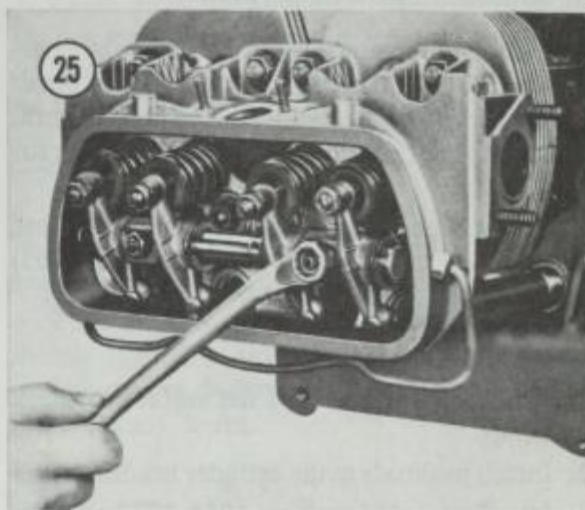
VALVE ROCKER ASSEMBLY

Removal

1. Clean away road dirt around the valve covers.

2. Pry the valve cover holder down and remove the valve cover.

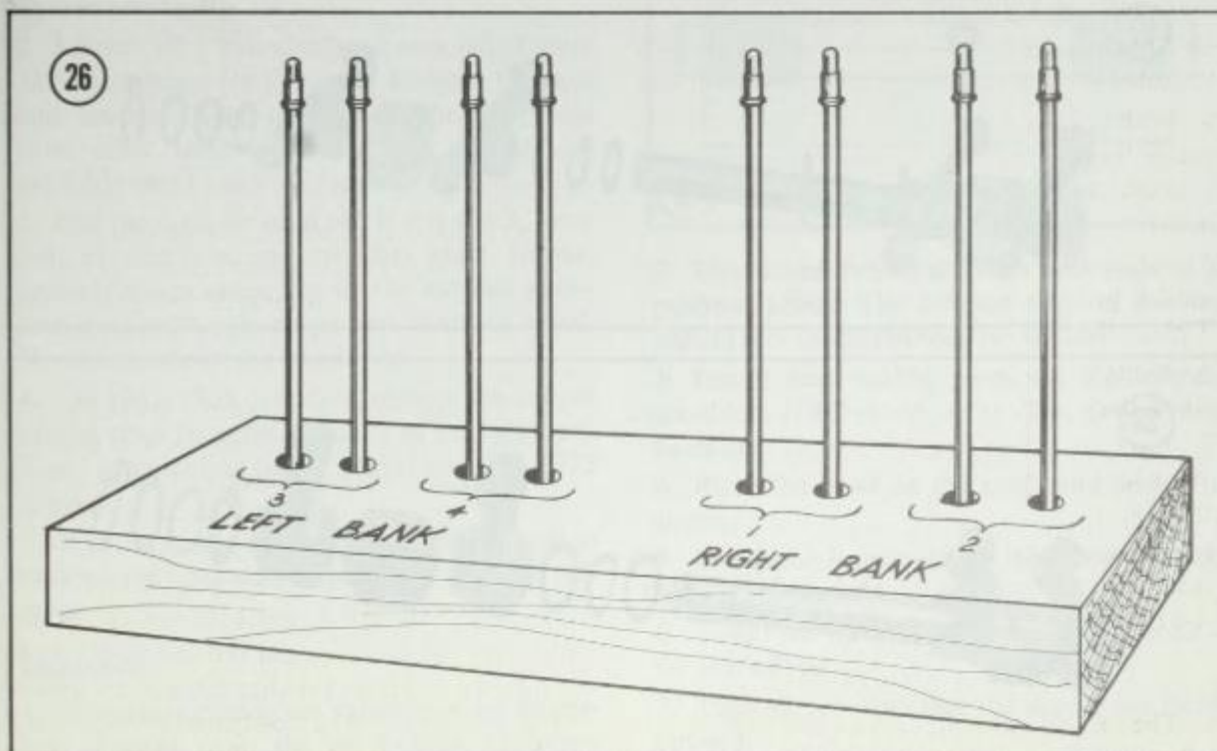
3. Remove the 2 rocker shaft support nuts and keep them separate from other hardware (see **Figure 25**). These are copper-plated and must be used to reinstall the rocker shaft.



4. Pull off the rocker shaft with rocker arms.

5. Remove the stud seals on 1966-1972 cylinder heads.

6. Remove all 4 pushrods and store them so that they may be reinstalled in exactly the same place. See **Figure 26**.



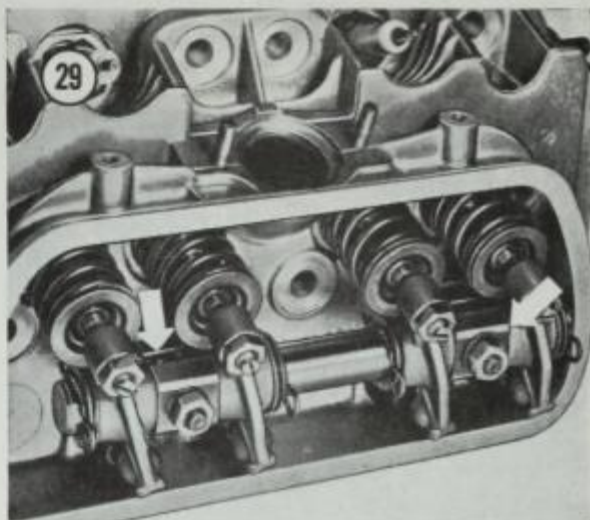
Rocker Shaft Disassembly / Assembly

1. Mark the rocker arms so they may be reinstalled in the same position.
2. Remove the end clips from the rocker arm shaft.
3. Slide all the parts off the shaft.
4. Clean all parts in solvent. Examine the bearing surfaces of the shaft and rocker arms. Small irregularities may be removed with crocus cloth. Check the rocker arm seats and ball sockets for wear.
5. Coat all parts with assembly lubricant and reassemble as shown in **Figure 27** (1961-1965) or **Figure 28** (1966-1972).

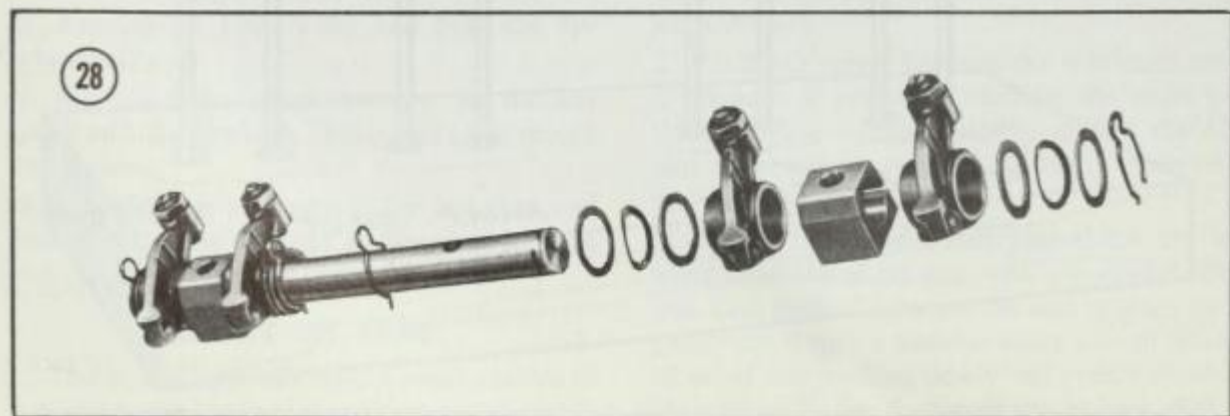
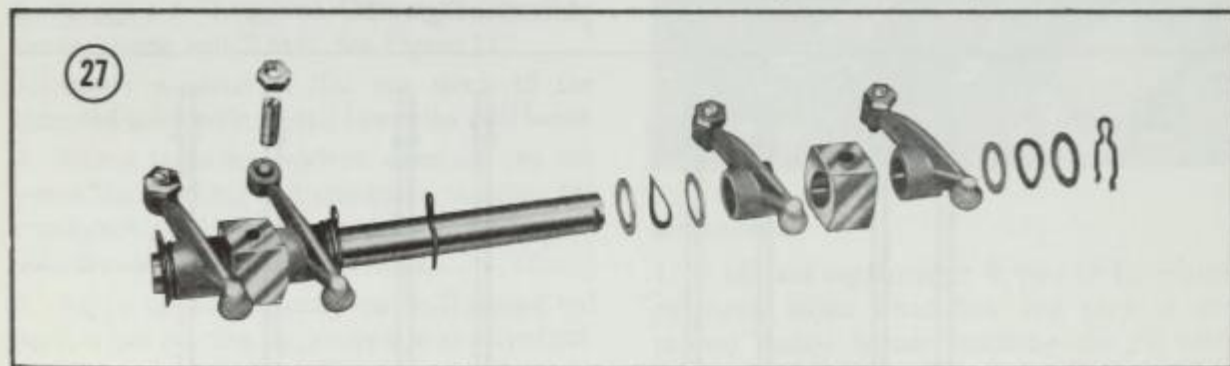
Installation

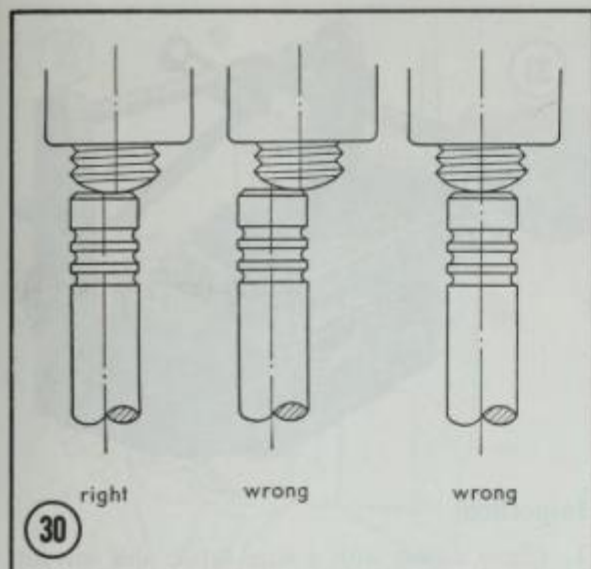
1. Roll each pushrod on a flat surface to check for bends.
2. Install pushrods in the cylinder head.
3. Install new stud seals on 1966-1972 cylinder heads. Most gasket kits provide 2 types of seals: donut-shaped and flat. If there is a recessed groove around the stud, use the flat seals. Otherwise use the donut-shaped seals.
4. Install the rocker shaft assembly. Note that

that chamfered edge of the 1966-1972 rocker shaft support points outward (away from the head) and the slot points upward. See **Figure 29**.



5. Ensure that the pushrod ball ends are centered in the rocker arm sockets. In addition, make sure that the rocker arm adjusting screws contact the valves slightly off-center as shown in **Figure 30**.
6. Tighten both nuts on the rocker shaft studs to 18 foot-pounds (2.5 mkg).





7. Adjust intake and exhaust valves. See Chapter Two.
8. Clean all traces of old gasket from the valve covers.
9. Hold new gaskets in place on the valve covers with grease. Install the cover.

CYLINDER HEADS

Removal

1. Remove the valve rocker assembly as described previously.
2. Loosen all 8 cylinder head nuts (see Figure 32A, next page, for location). Remove the nuts and washers. Keep all head washers separate from other hardware. They are special and available only from VW if lost.
3. Pull the cylinder head off. If it is stuck, carefully pry the head and cylinders apart. In particularly tough cases, tap on the exhaust manifold studs with a hammer and block of wood. Never hammer on the fragile fins.
4. On 1961-1965 cylinders, remove the copper sealing rings from the shoulder of the cylinders. There is no sealing ring or gasket on 1966-1972 engines.
5. If performing a valve job, it is unnecessary to remove the cylinders. Tie them on with soft wire.

Inspection

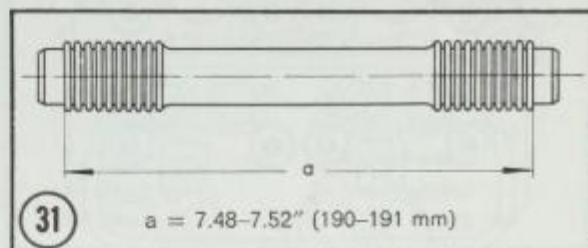
1. Without removing the valves, remove all carbon deposits from the combustion chambers

with a wire brush. A blunt screwdriver or chisel may be used if care is taken not to damage the head or valves.

2. After all carbon is removed from the combustion chamber, both valves, intake and exhaust ports, clean the entire head with solvent.
3. Clean away all carbon on the piston crown. Do not remove the carbon ridge at the top of the cylinder bore.
4. Check for cracks in the combustion chamber and exhaust ports. Cracked heads must be replaced.
5. Check all studs for tightness. If a stud can't be tightened, have a machinist drill the hole out and install a Heli-coil threaded insert.
6. Push the valve stem ends sideways with your thumb. If there is any play, the valve guides are probably worn. Replace them as described later if there is any doubt.

Installation

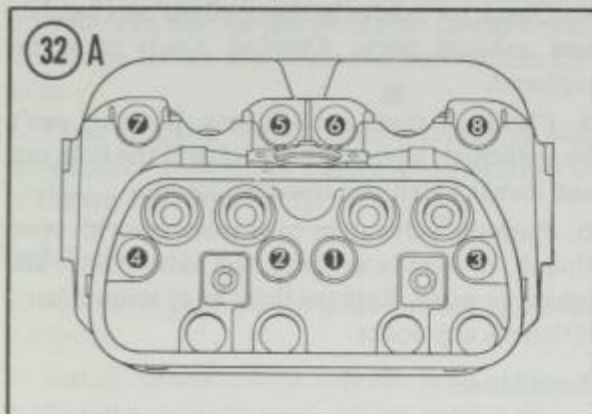
1. Stretch the pushrod tubes to dimensions shown in Figure 31. This can be done by hand. First insert a dowel or rod in the tube to keep the tube from bending. Then stretch each end out until the proper dimension is reached. Do this carefully so the tubes are not cracked.



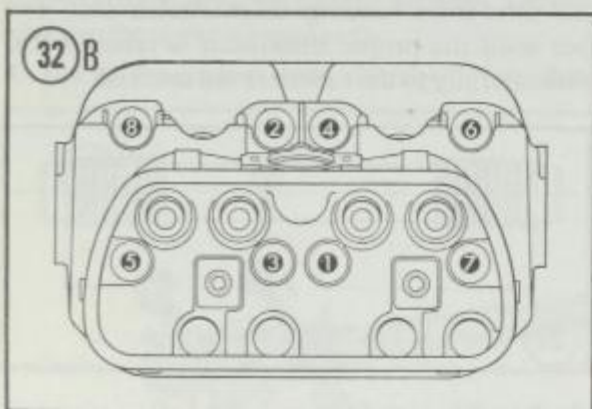
2. Install new rubber seals on both ends of all pushrod tubes. The beveled edge of the seal should face toward the end of the tube.
3. Install new sealing rings on the cylinder shoulders (1961-1965 only). The narrow edge faces out.
4. Place the head on the studs and push it in slightly.
5. Install the inner pushrod tubes and push the head in further.
6. Install the outer tubes and push the head as far as it will go.
7. Turn all tubes so that the seams are facing upward.

8. Install at least 1 head nut and washer. If the washer won't fit at this time, install the nut without it. Tighten the nut until the other washers and nuts can be installed. Then be sure to install a washer under the first nut. Remember these are special thick washers available only from VW.

9. Tighten the nuts to 7 foot-pounds (1 mkg) in the order shown in **Figure 32A**.



10. Tighten the nuts to 22-23 foot-pounds (3-3.2 mkg) in the order shown in **Figure 32B**.



VALVES & VALVE SEATS

Removal

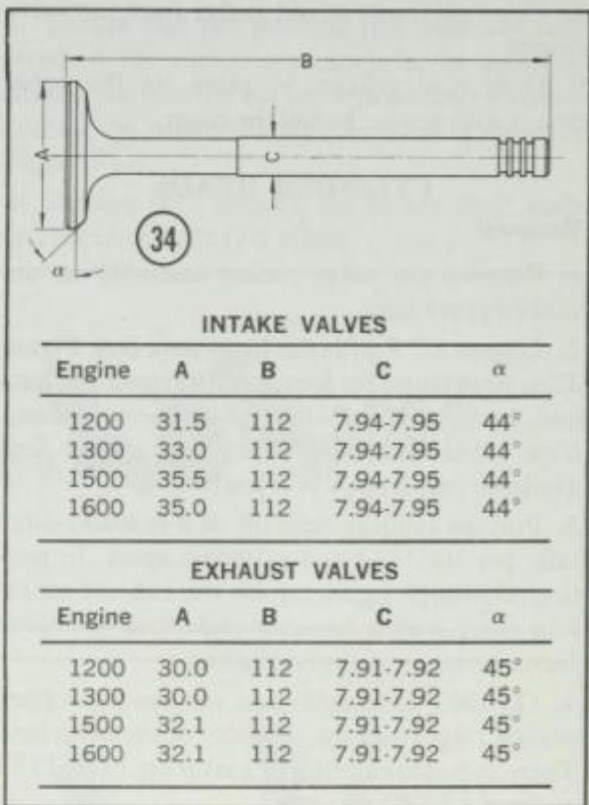
1. Remove cylinder head.
2. Compress springs with a valve spring compression tool, remove the valve keepers and release compression. See **Figure 33**.
3. Remove the valve spring caps, springs, oil deflector rings (1966-1972 only) and valves.

CAUTION: Remove any burrs from valve stem grooves before removing valves. Otherwise the valve guides will be damaged.

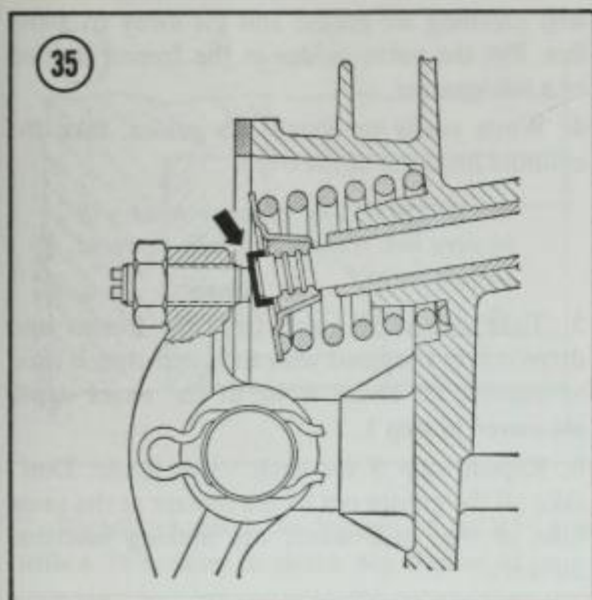


Inspection

1. Clean valves with a wire brush and solvent. Discard burned, warped or cracked valves. If any valves are to be refaced, refer to **Figure 34** for critical dimensions.



2. Measure the valve stems for wear. Compare with specifications. VW dealers have small caps to fit over damaged valve stem ends to make them reusable. See **Figure 35**. Use caps on an otherwise healthy engine to avoid disassembly. If engine is apart for overhaul, recommend procedure is to reface valve stems.



3. Remove all carbon and varnish from valve guides with a stiff spiral wire brush.

4. Insert each valve in its guide. Hold the valve just slightly off its seat and rock it sideways. If it rocks more than slightly, the guide is worn and should be replaced. See Valve Guide Replacement later in this section.

5. Measure the valve spring heights. All should be of equal length with no bends or other distortion. Replace defective springs.

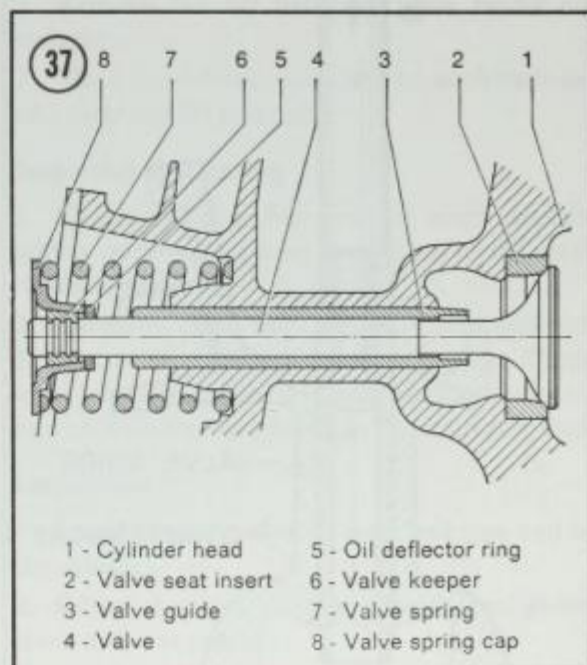
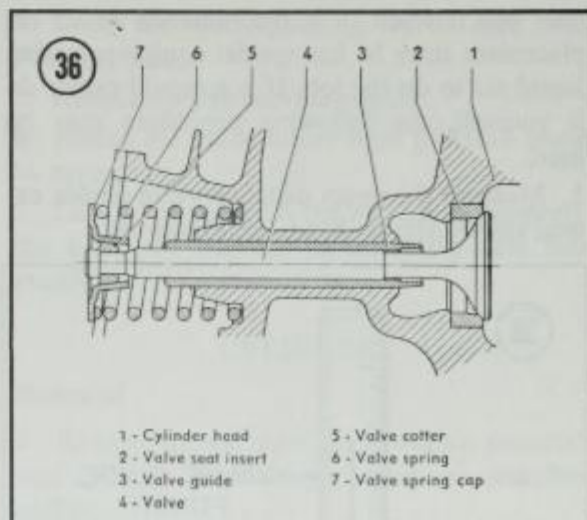
6. Test valve springs under load. Springs should compress to 1.22" (31mm) with a 126 ± 8.8 pound (57 ± 4 kg) load. Replace any which fail this test.

7. Check the valve keepers. If they are reusable, grind the joining faces until it is still possible to turn the valve while holding the keeper halves pressed together. New keepers must be ground in the same manner.

8. Inspect valve seats. If worn or burned, they must be reconditioned. This should be performed by the dealer or local machine shop, although the procedure is described later in this section. Seats and valves in near perfect condition can be reconditioned by lapping with fine carborundum paste. Lapping, however, is always inferior to precision grinding.

Installation

Refer to **Figure 36** (1961-1965) or **Figure 37** (1966-1972) for the following procedure.



1. Coat the valve stems with molybdenum disulfide paste and insert them into the cylinder head.

2. Install oil deflector rings with sleeves (1966-1972 only).

3. Install valve springs with close-pitched coils next to cylinder head.

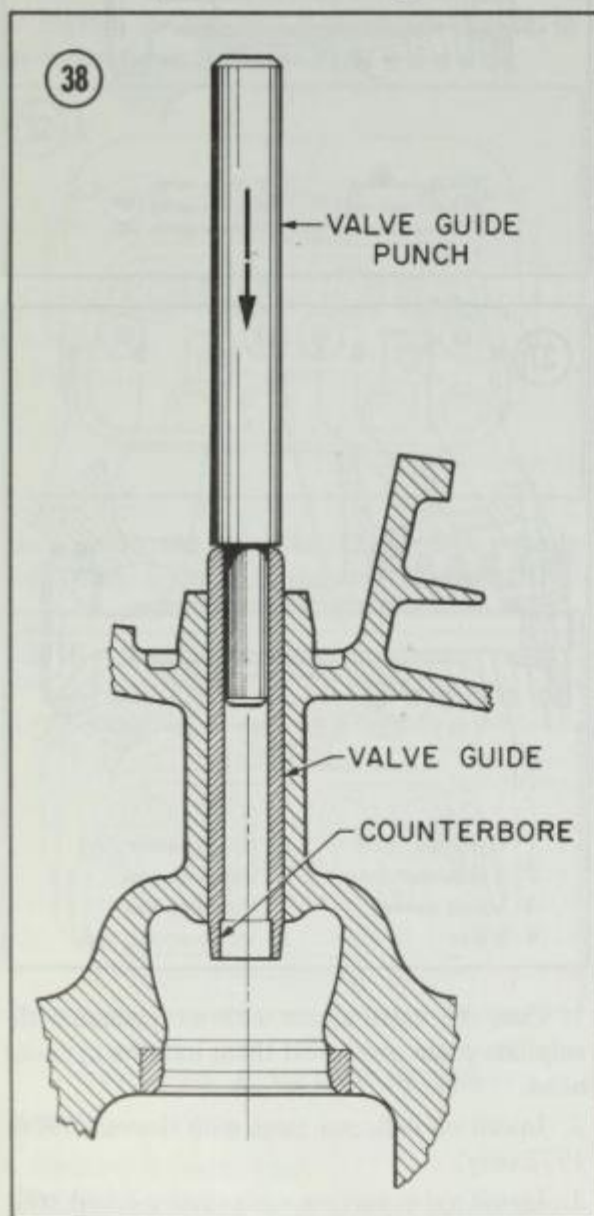
4. Install valve spring caps, compress springs, and install valve keepers.

Valve Guide Replacement

When valve guides are worn so that there is excessive stem-to-guide clearance or valve tipping, they must be replaced. Replace all even if

only one is worn. VW recommends dealer replacement since he has special equipment using liquid air to do the job. If you would rather do it yourself, the following procedure may be used.

1. Measure the exact distance valve guides extend above cylinder head. See **Figure 38**.



2. Place punch with a pilot in the guide. The punch diameter should be a few thousandths of an inch smaller than the guide diameter so that the punch does not bind in the guide hole. Hold the punch firmly, and drive the valve guide out.

3. To make insertion of the new guides easier, put the cylinder head in an oven set for 300°F,

first cleaning all grease and oil away to avoid fire. Put the valve guides in the freezer section of a refrigerator.

4. When ready to install the guides, take the cylinder head out of the oven.

WARNING: *The cylinder head will be very hot. Handle carefully to avoid serious burns.*

5. Take one valve guide from the freezer and drive it into the head with the same punch used to remove it. Drive it in to the **exact depth measured in step 1**.

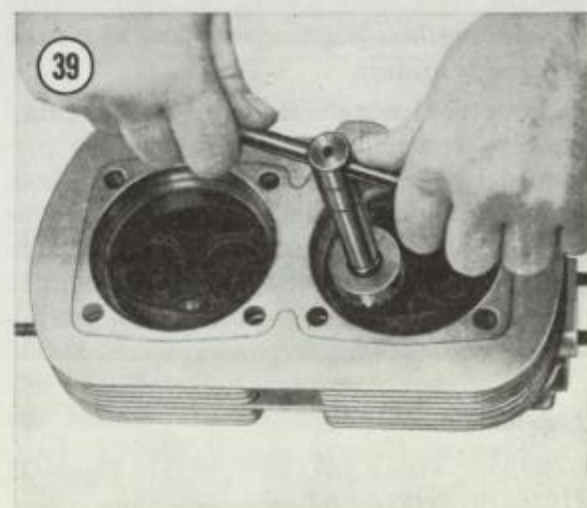
6. Repeat step 5 for each valve guide. Don't take all the guides out of the freezer at the same time or they will warm up, making insertion difficult.

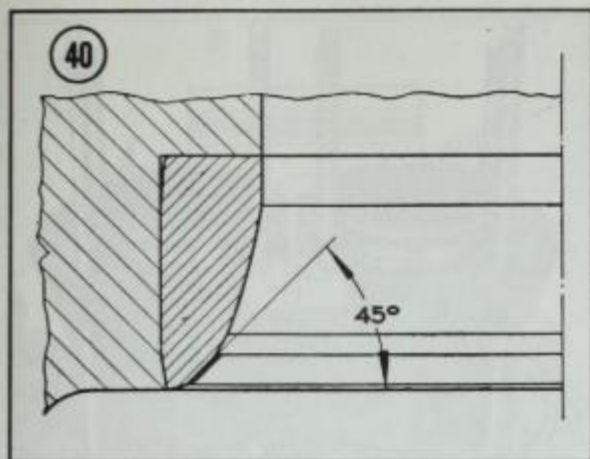
Valve Seat Reconditioning

This job is best left to your dealer or local machine shop. They have the special equipment and knowledge required for this exacting job. The following procedure is provided in the event you are not near a dealer and the local machine shop is not familiar with VW's.

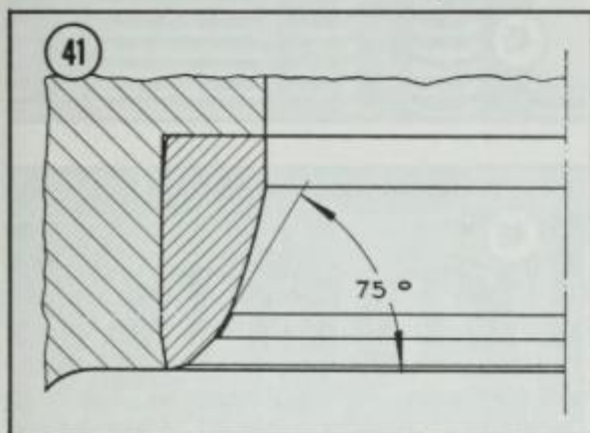
Valve seats are shrunk into the cylinder heads. Damaged or burned seats may be reconditioned until the edge of the top 15° chamfer reaches the outer edge of the valve seat. After this point is reached, the cylinder head must be replaced.

1. Using a 45° valve seat cutter or special stone, cut the 45° face. Don't take off any more metal than necessary to provide a clean, concentric seat. See **Figures 39 and 40**.

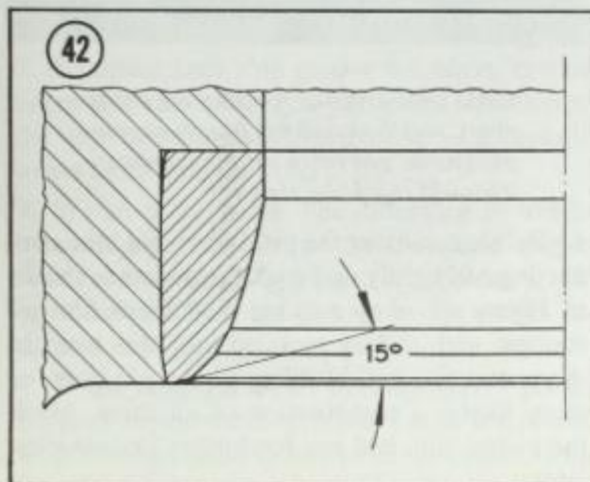




2. Slightly chamfer the bottom of the 45° seat with a 75° cutter or stone. See **Figure 41**.



3. Narrow the width of the 45° valve seat by cutting the top of the seat with a 15° cutter or stone. See **Figure 42**. The table of specifications at the end of this chapter shows intake and exhaust seat width for your engine.



4. Coat the corresponding valve face with Prussian blue.

5. Insert the valve into the guide.

6. Rotate the valve under light pressure about 1/4 turn.

7. Lift the valve out. If the valve seats properly, the blue will transfer to the valve seat face evenly.

CYLINDERS

Removal

1. Remove the valve rocker assembly, pushrods and cylinder head using procedures described earlier.

2. Remove the air deflector plate below the cylinders.

3. Mark the cylinder numbers on each cylinder and carefully lift them off.

Inspection & Cleaning

1. Check the bore for wear. If worn, replace with a matched cylinder and piston of the same displacement.

2. Carefully clean the cylinder inside and out. Brush out all dirt from between the fins. Clean away any dirt on the cylinder sealing surfaces, and remove the old gasket on the crankcase end.

Installation

1. Install a new gasket on the crankcase end of the cylinder.

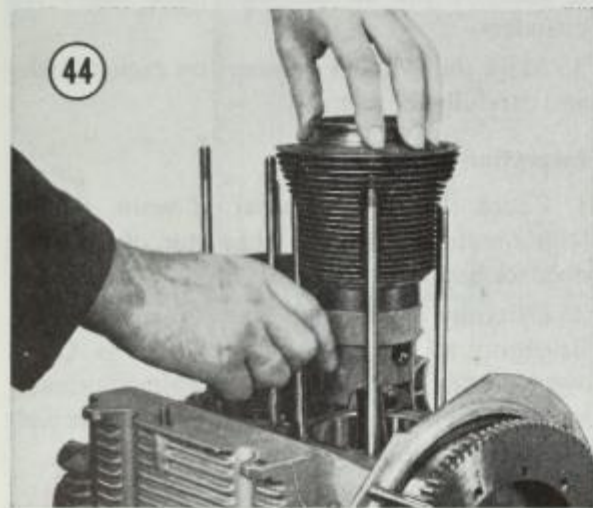
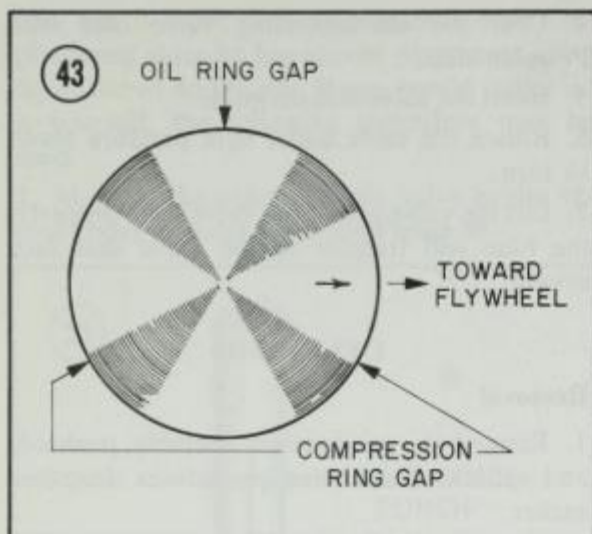
2. Rotate the crankshaft until the desired piston is out as far as possible.

CAUTION: While rotating the crankshaft, watch that skirts of any exposed pistons do not catch on the crankcase. This will crack the piston.

3. Apply a heavy coat of assembly lubricant to the piston.

4. Make sure the oil ring gap is straight up. The other 2 ring gaps should be evenly spaced 120° apart. See **Figure 43**. Compress the rings with a ring compressor. The compressor must be a 2-piece breakaway type so it can be removed.

5. Liberally oil the cylinder bore and slide the cylinder over the piston. See **Figure 44**. Be careful not to break any cooling fins against the studs.



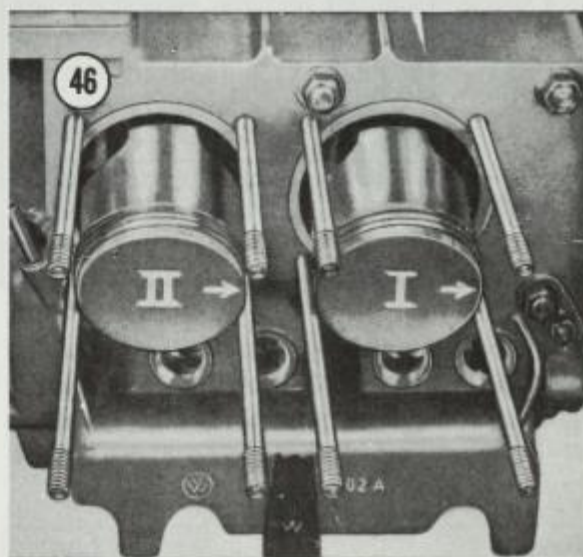
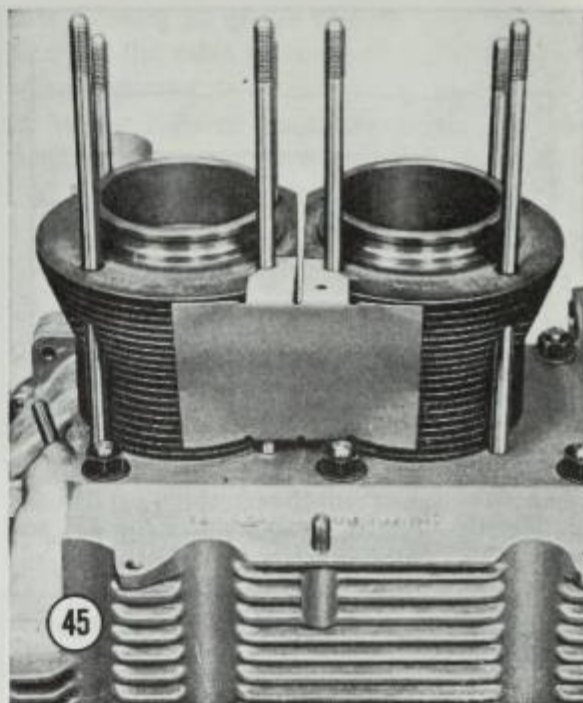
6. When both cylinders on one side are in place, clip the air deflector in place. See **Figure 45**. If necessary, bend the plate so that it fits tightly against the cylinders and won't rattle loose later on.

7. Install the cylinder head as described previously.

PISTONS, PINS, AND RINGS

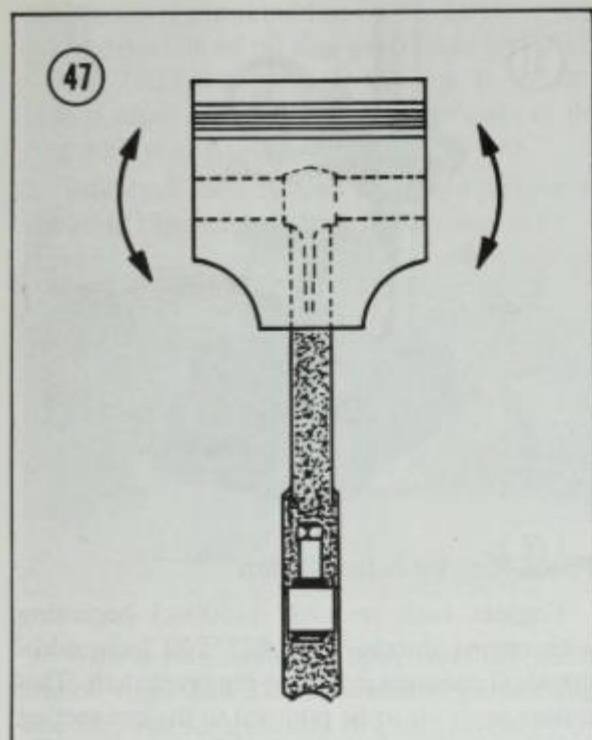
Removal

1. Remove the cylinder head and cylinders as described previously.
2. Mark the piston to make sure it is re-installed in the same cylinder. See **Figure 46**. Counting from the flywheel, pistons are numbered 1, 2 on the right bank and 3, 4 on the left bank.
3. Rotate the crankshaft until the desired piston is out as far as it goes.



CAUTION: While rotating the crankshaft, watch that skirts of any exposed pistons do not catch on the crankcase. This will crack the piston.

4. Before removing the piston pin, hold the connecting rod tightly and rock the piston as shown in **Figure 47**. Any rocking movement (do not confuse with sliding motion) indicates wear in the piston pin, rod bushing, piston pin bore, or more likely, a combination of all three. Mark the piston, pin, and rod for further examination later.



5. Remove the snap rings at each end of the piston pin.

6. Turn the engine so that the crankshaft is vertical, and place wet rags around the oily areas of the crankcase.

7. Heat the piston and pin with a small butane torch. The piston pin will probably drop right out, but may need coaxing with a metal rod. Heat the piston to 176°F (80°C), i.e., until it is too warm to touch, but not excessively hot.

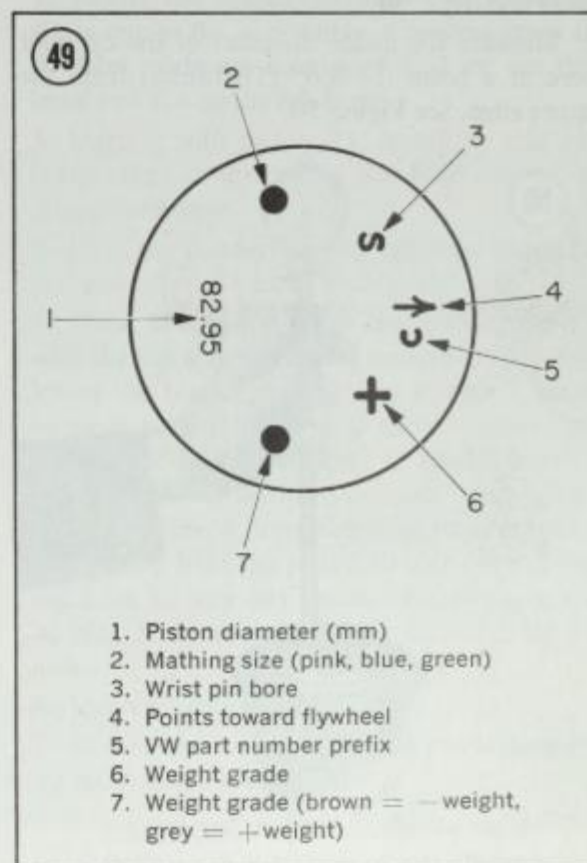
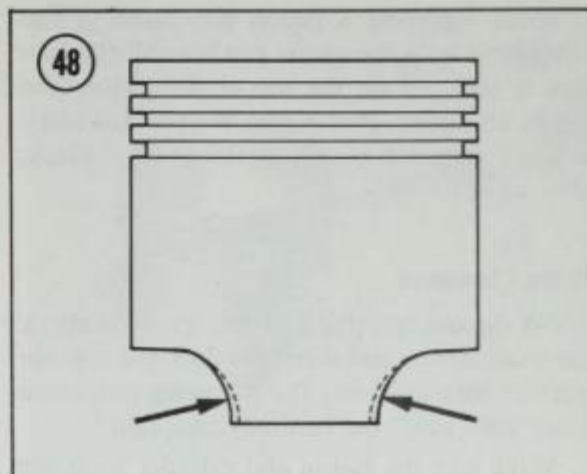
Inspection

1. Clean the piston thoroughly in solvent. Scrape carbon deposits from the top of the piston and ring grooves. Don't damage the piston.

2. Examine each ring groove for burrs, dented edges and side wear. Pay particular attention to the top compression ring groove as it usually wears more than the others.

3. Weigh each piston. The difference in weight between any two pistons in the same engine must not exceed 10 grams. If necessary, file metal off the heaviest pistons at the points indicated in **Figure 48**.

4. If the damage, wear, or weight of a piston suggests replacement, replace it with a size and weight comparable to others in the engine. **Figure 49** shows markings on the top of each VW



1. Piston diameter (mm)
2. Mating size (pink, blue, green)
3. Wrist pin bore
4. Points toward flywheel
5. VW part number prefix
6. Weight grade
7. Weight grade (brown = - weight, grey = + weight)

piston used to identify its size, weight range, and assembly orientation.

NOTE: Although 1970-1972 pistons are the same diameter, 1972 pistons have recessed crowns and are not interchangeable with 1970-1971 pistons.

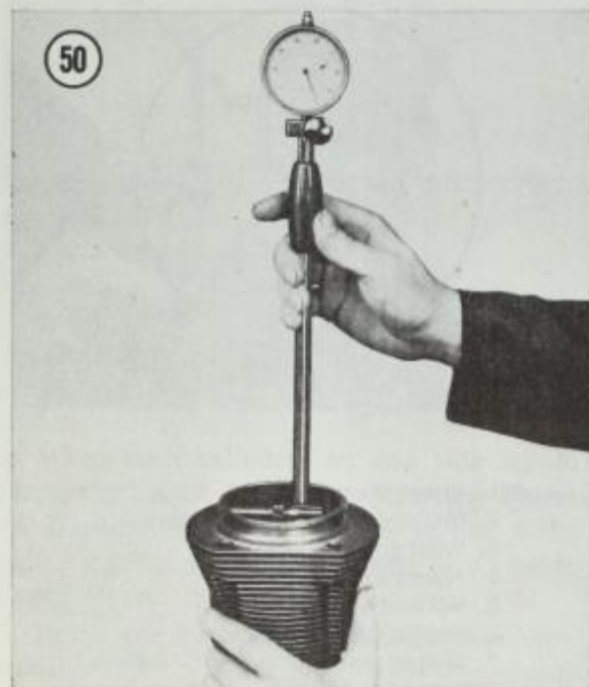
5. Measure any parts marked in step 4, Piston Removal, with a micrometer to determine which part or parts are worn. Any machinist can do this for you if you do not have micrometers.

6. When replacing a piston pin, select a size compatible with the piston pin bore. Piston pin bore is stamped on the top of the piston (see Figure 49 again). Piston pins are painted black or white to match piston markings (S = black, W = white).

Piston Clearance

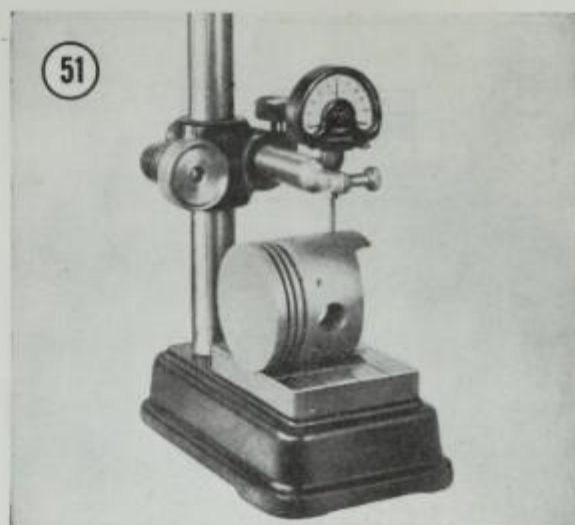
VW discourages using a feeler gauge to check piston clearance and therefore does not provide specifications to do so. The following procedure is the "hard way", but certainly adequate.

1. Make sure the piston and cylinder walls are clean and dry.
2. Measure the inside diameter of the cylinder bore at a point 0.4-0.6" (10-15mm) from the upper edge. See Figure 50.



3. Measure the outside diameter of the piston at the bottom of the skirt. See Figure 51.

4. If the difference in the two readings is near 0.008" (0.2mm) or the engine oil consumption is greater than 1 quart in 600 miles (1 liter/1000 km), the piston/cylinder combination requires overhaul. If cylinder bore is excessive, replace the cylinder and piston. If the piston is worn or damaged you may replace the piston only. Choose one which is the correct size and weight.



Piston Ring Fit & Installation

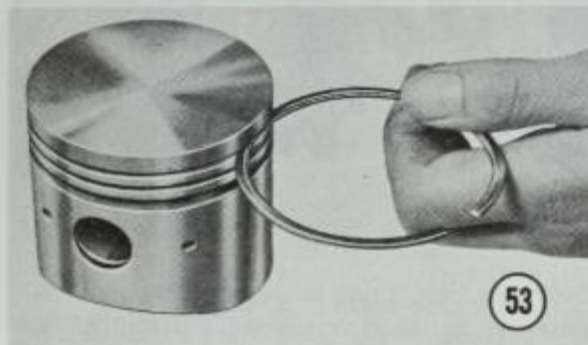
Engines built in 1967 (1500cc) beginning with engine number HO 823 800 have additional oil passages drilled in the crankshaft. This causes more oil to be pumped to the connecting rod bearings and requires different rings. To avoid trouble, order new rings by chassis number and engine number. Even though the rings for earlier engine numbers fit, **they must not be interchanged.** To avoid trouble, always order parts by chassis and engine number.

1. Check the ring gap of each ring. To check a ring, insert it in the bottom of the cylinder bore, and square it with the wall by tapping with a piston. The ring should be in about 0.2". Insert a feeler gauge as shown in Figure 52. A com-



pression ring gap should be 0.012-0.018" (0.30-0.45mm) while an oil ring gap should be 0.010-0.016" (0.25-0.40mm). If the gap is smaller, hold a small file in a vise, grip the ends of the ring with your hands and enlarge the gap.

2. Roll each ring around its piston groove as shown in **Figure 53** to check for binding.



3. With a ring expander tool, carefully install the oil ring, then 2 compression rings (see **Figure 54**). The compression ring side marked **TOP** must be up.



4. Check the side clearance of the ring as shown in **Figure 55**. Compare with the specifications for your engine.

Piston Installation

1. Install the rings on all 4 pistons using the preceding procedures.



2. Rotate the crankshaft until connecting rod #1 is out as far as possible. Counting from the flywheel, rods are numbered 1, 2 on the right bank and 3, 4 on the left bank.

3. Starting with piston #1, install an end lock (snap ring) in the piston pin hole nearest the alignment arrow.

4. Coat the connecting rod bushing, piston pin and piston holes with assembly lubricant.

5. Place the piston over the connecting rod **with the top arrow pointing toward the flywheel**. Insert the piston pin and tap it with a plastic hammer until it starts into the connecting rod bushing. If it doesn't slide in easily, heat the piston until it is warm to the touch, but not too hot. Continue to drive the piston pin in. While hammering hold the piston so that the rod does not have to take any shock. Otherwise, it may be bent. Drive the pin in until it touches the end lock.

6. Insert the other end lock.

7. Rotate the crankshaft until connecting rod #2 is out as far as it will go.

CAUTION: While rotating the crankshaft watch that skirts of any exposed pistons do not catch on the crankcase. This will crack the piston.

8. Repeat steps 3-9 for piston #2, #3, and #4. When all are installed, check that all arrows on the pistons point toward the flywheel.

OIL PUMP

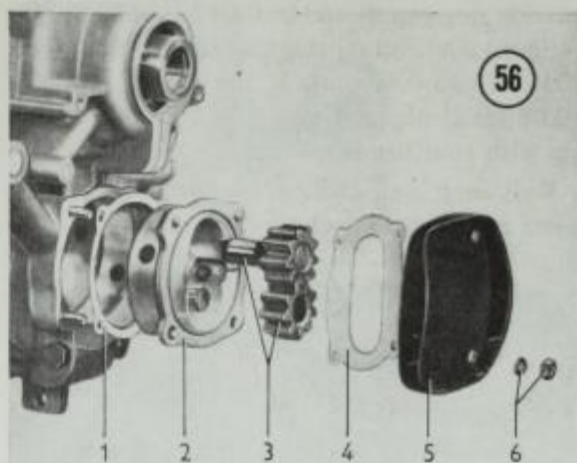
Different oil pumps are used on manual and automatic stick shift cars. Manual shift cars have a single gear-type pump for engine oil.

Automatic stick shift cars have an additional transmission oil pump mounted on the engine oil pump.

Engine oil pumps for 1600 engines (1970-1972) are larger than earlier pumps. However, repair procedures are identical. Oil pumps can be replaced with the engine installed in the car.

Removal

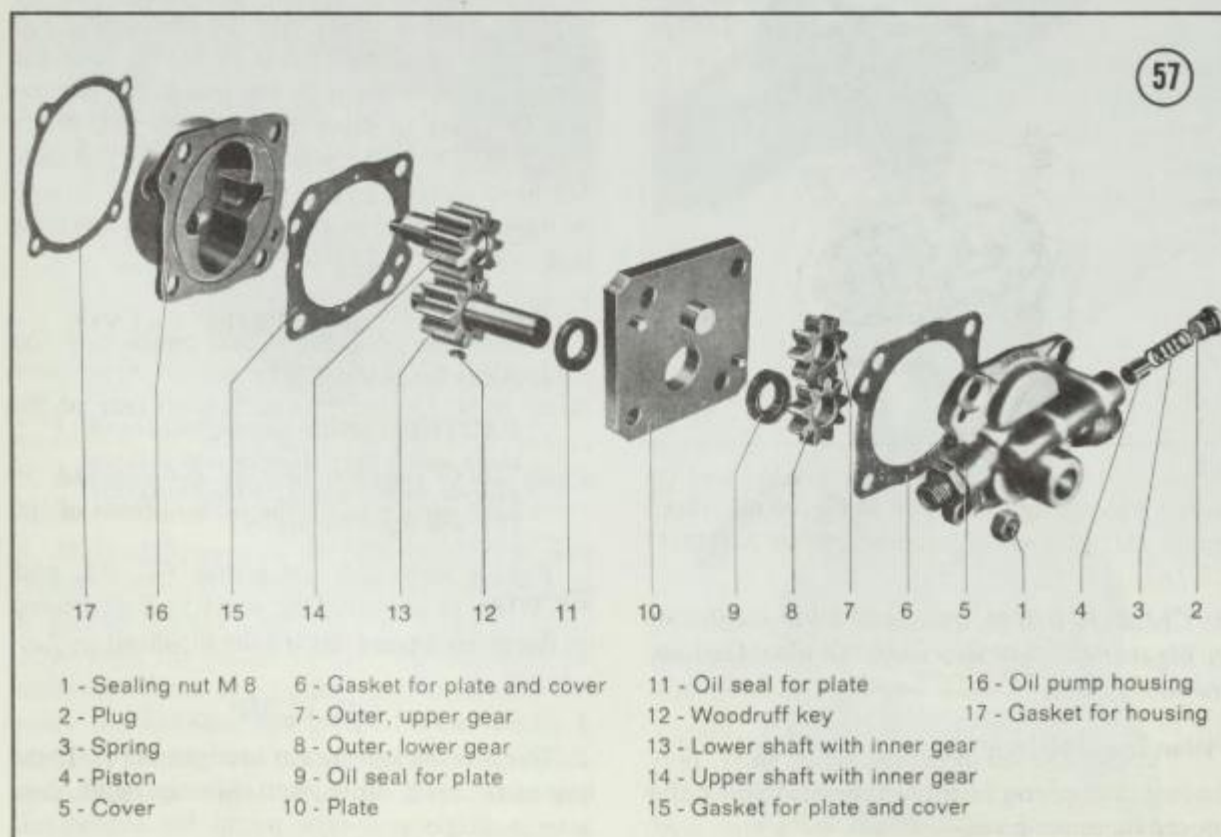
1. If engine is still in the car, remove rear cover plate, crankcase pulley, and lower fan pulley plate.
2. Remove oil pump cover nuts. Remove cover and gasket.
- 3a. On single pumps (manuals) remove the gears (3). See **Figure 56**.
- 3b. On dual pumps (automatics) remove the transmission oil pump gears (7 & 8), plate (10), engine oil gears (13 & 14), and gasket (15). See **Figure 57**.
4. Mark the crankcase and oil pump body on the outside edge to aid reassembly. Do not mark on the sealing surface of the pump body.
5. Remove the oil pump body with an extractor. See **Figure 58**.



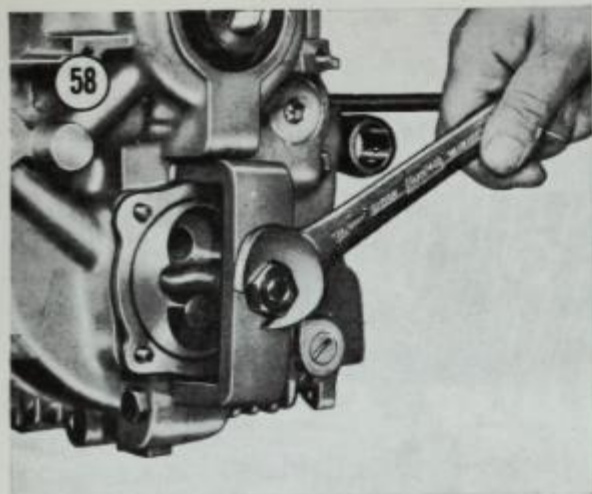
- | | |
|-------------------|--------------------|
| 1 - Gasket | 4 - Gasket |
| 2 - Oil pump body | 5 - Oil pump cover |
| 3 - Gears | 6 - Nut and washer |

Inspection

1. Clean all parts thoroughly in solvent.
2. Check oil pump cover and plate (automatics) for excessive wear or scoring. Replace if necessary.
3. Check gear seats in oil pump body for wear which can lower oil pressure to dangerous levels.



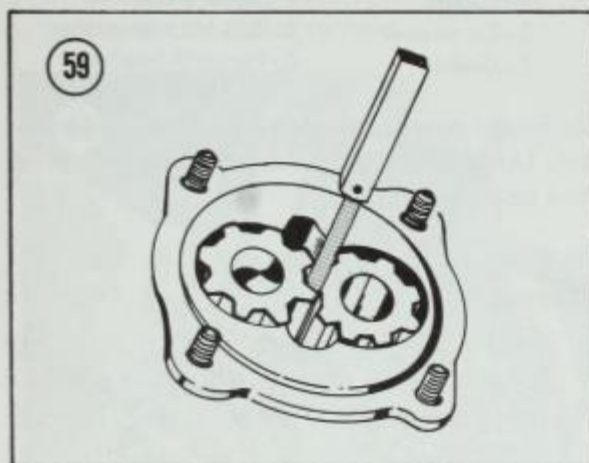
- | | | | |
|---------------------|--------------------------------|----------------------------------|-------------------------|
| 1 - Sealing nut M 8 | 6 - Gasket for plate and cover | 11 - Oil seal for plate | 16 - Oil pump housing |
| 2 - Plug | 7 - Outer, upper gear | 12 - Woodruff key | 17 - Gasket for housing |
| 3 - Spring | 8 - Outer, lower gear | 13 - Lower shaft with inner gear | |
| 4 - Piston | 9 - Oil seal for plate | 14 - Upper shaft with inner gear | |
| 5 - Cover | 10 - Plate | 15 - Gasket for plate and cover | |



4a. Check the engine oil pump idler gear shaft for tightness. If necessary, peen the oil pump body lightly or replace it.

4b. Check the transmission oil pump idler gear shaft for tightness. Replace it if the shaft is loose.

5. Install engine oil gears in pump body. Check backlash by inserting a feeler gauge between gear teeth as shown in **Figure 59**; backlash should be 0.0012-0.0031" (0.03-0.08mm).



Place a square over the oil pump body and insert a feeler gauge as shown in **Figure 60**. Maximum end play without cover gasket is 0.004" (0.1mm).

6. On dual pumps only, leave the engine oil gears in place as in step 5. Install plate (10) and gears (7 & 8). Check backlash with a feeler gauge.

7. Remove the oil pressure relief valve plug, spring, and piston in the transmission oil pump cover (automatic only). Check for piston wear



and scoring. Examine the spring for distortion. Replace questionable parts.

8. Check the mating surfaces on the pump body and crankcase for dirt and damage.

Installation

1. Clean all parts in solvent just prior to installation, even though they were thoroughly cleaned for inspection.

2. Install the pump body in the crankcase using a new gasket. Line up the marks made during removal.

3. Coat all internal parts with assembly lubricant and assemble the pump as shown in Figure 56 or 57.

4. Install the transmission oil pump pressure relief valve parts (2, 3, & 4).

OIL PRESSURE RELIEF VALVES

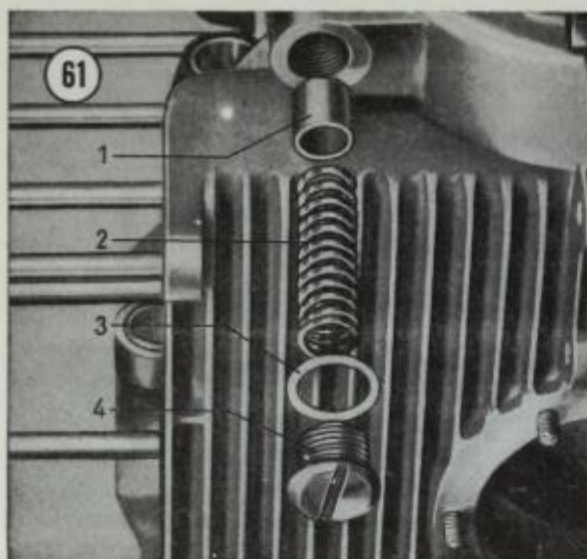
On 1961-1972 engines there is an oil pressure relief valve located on the bottom rear of the engine near the oil pump. On 1970 through 1972 (1600) engines there is an additional oil pressure relief valve on the bottom front of the engine near the flywheel.

Removal

Refer to **Figure 61** for the following procedure.

1. Remove the plug (4) and gasket (3).

2. Remove the spring (2) and piston (1). If the piston is stuck, thread a 10mm tap lightly into it and pull it out.



1 - Plunger
2 - Spring
3 - Gasket
4 - Plug

Inspection

1. Check the crankcase bore and piston for signs of scoring or seizure. Dress the bore with crocus cloth and replace the piston if necessary.
2. Measure the spring length. Unloaded length should be 2.44-2.52" (62-64mm).

Installation

Install the piston, spring, new gasket, and plug in the order shown in Figure 61.

OIL STRAINER

The oil strainer can be removed with the engine installed.

Removal

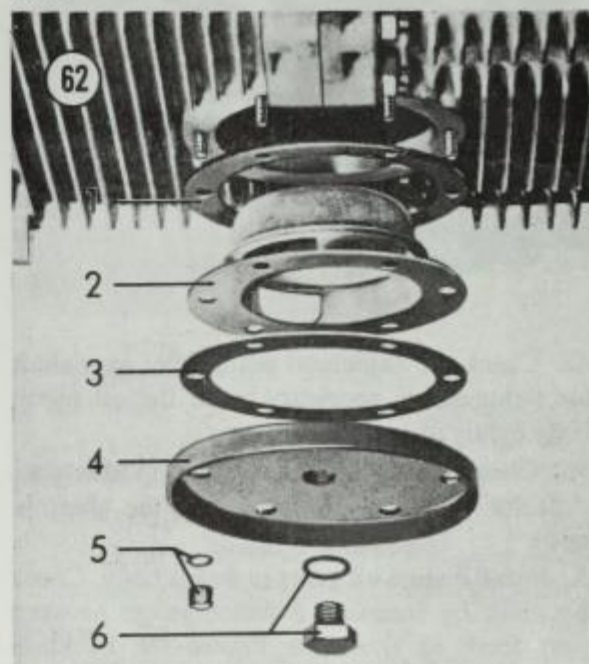
1. Drain engine oil.
2. Remove 6 nuts securing the cover plate and remove the plate.
3. Remove oil strainer and 2 gaskets.

Inspection

1. Check that the oil suction pipe is tight and centered in the large hole. If not, the engine must be dismantled and the right crankcase half peened. See Crankcase Inspection.
2. Clean all parts in solvent and remove all traces of old gasket.
3. Check that the cover plate is not bent. Straighten or replace if necessary.

Installation

1. Install all parts in the order shown in Figure 62. Note that a different strainer is used from 1968-1972. There is no difference in installation.



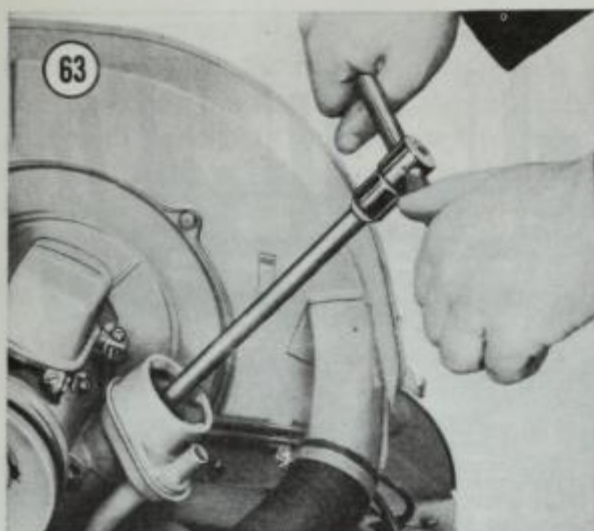
1 - Gasket
2 - Oil strainer
3 - Gasket
4 - Cover plate
5 - Cap nut with washer
6 - Plug with washer

2. Secure cover plate with 6 nuts and new washers. Do not overtighten, or the plate will bend and cause leaks.

CRANKCASE

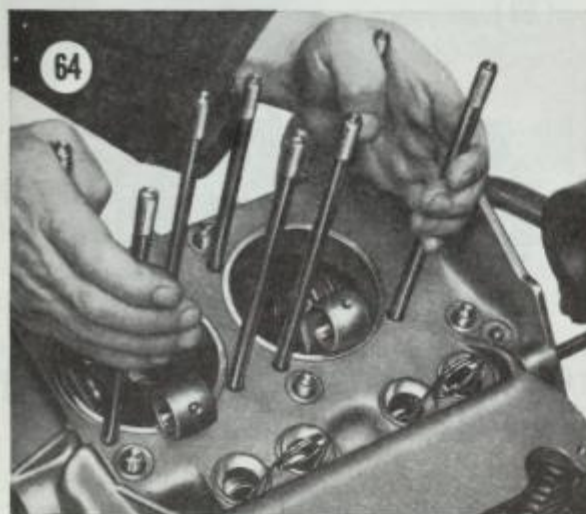
Disassembly

1. Remove the oil pressure switch.
2. Remove the oil filler by pulling off the connecting hose, and unscrewing the internal threaded ring (see Figure 63).
3. Remove the 6 bolts securing the oil strainer on the bottom of the crankcase. Pull off the cover, 2 gaskets and strainer (see Figure 62 again).
4. Tip the crankcase so that it leans on the left half cylinder studs. Remove all 13mm nuts. Loosen the 6 large nuts (17mm).
5. Pull the oil pump out, and remove all 6 large nuts.
6. Check carefully all around the crankcase for any remaining nuts.



7. Loosen the right half of the crankcase by tapping with a rubber hammer or block of wood. Keep pulling upward on the crankcase half and tapping with the hammer until the right half is free. See **Figure 64**. Four valve lifters will fall out, so watch for them.

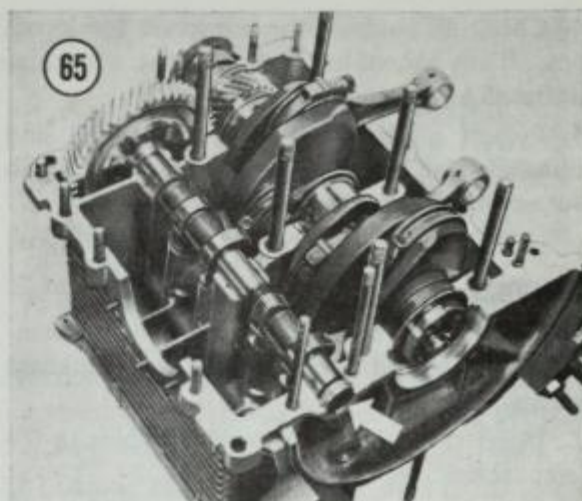
CAUTION: *Never try to pry the crankcase halves apart with a screwdriver or similar object or you will damage the sealing surfaces.*



8. Remove the camshaft end seal, shown in **Figure 65**, and lift the camshaft out.

9. Lift the crankshaft out.

10. Remove the center crankshaft bearing inserts. On 1966-1972 engines, remove the camshaft bearing inserts; there are none on earlier engines.



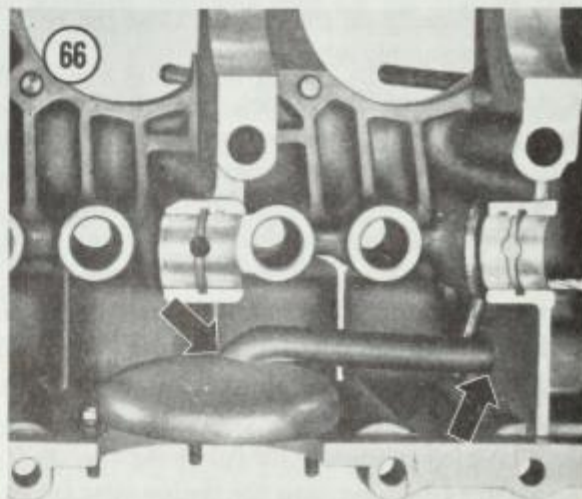
11. Remove the oil pressure relief valves as described in an earlier procedure.

Inspection

1. Clean and flush both halves of the crankcase with solvent. Blow out oil passages with air. Remove all traces of old sealing compound on mating faces.

2. Check both crankcase halves for cracks and other damage. Mating and sealing surfaces should be free of nicks and scratches or they will leak.

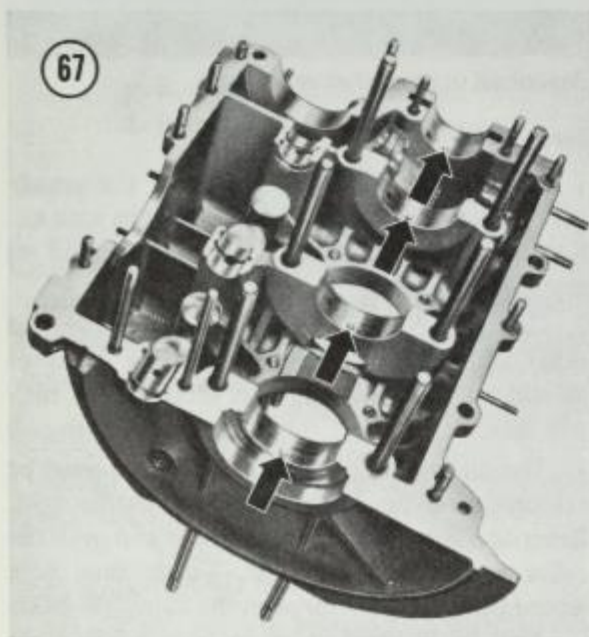
3. The oil suction pipe in the right half must be centered over the large hole and must be tight. Refer to **Figure 66**. If not, center it and peen the crankcase around the pipe. To do this, note where the pipe goes through the camshaft bearing web (right-hand arrow in **Figure 66**). Peen all around the pipe on the side of the web opposite the arrow.



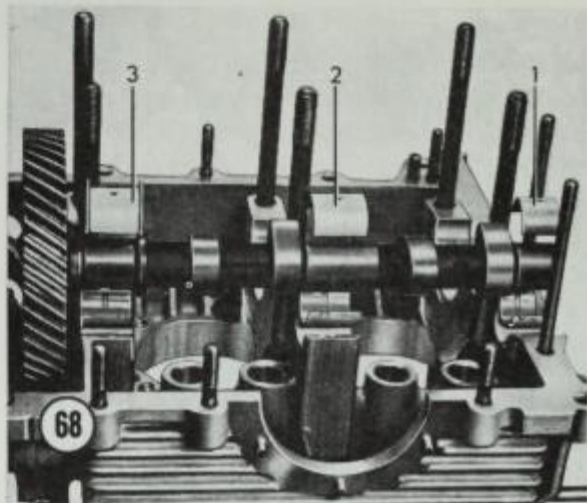
4. Check all studs in the crankcase for looseness. If any cannot be tightened, have a machinist install a Heli-coil insert.
5. Inspect all bearing bores (crankshaft and camshaft) for burrs. Remove with a file. Flush out any metal particles.

Assembly

1. Coat the cam followers (tappets) with assembly lubricant and insert them in the crankcase halves.
2. Insert crankshaft bearing dowel pins in the left case half. See **Figure 67**.

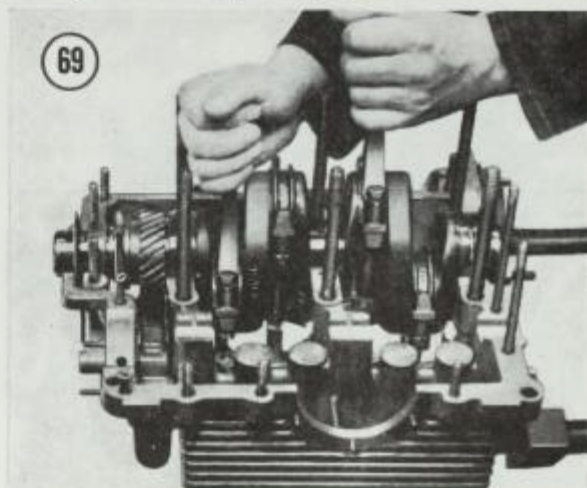


3. Install crankshaft bearing inserts for #2 bearing in crankcase halves. Ensure that the inserts fit properly on the dowels. Coat the bearings with assembly lubricant.
4. On 1966-1972 engines, install camshaft bearing inserts in the crankcase halves. Make sure the tangs on the bearings fit in the notches. Note that bearing #3, which fits in the left crankcase half, has shoulders to support axial loads from the camshaft. Refer to **Figure 68**.
5. Coat the inside of #1 and #4 main bearings and crankshaft journals with assembly lubricant.
6. Slide #1 bearing (with thrust flanges) onto the flywheel end of the crankshaft with the dowel pin hole closest to the flywheel end.
7. Slide #4 bearing onto the timing gear (rear)



end of the crankshaft with slot inside the bearing facing toward the timing gear end.

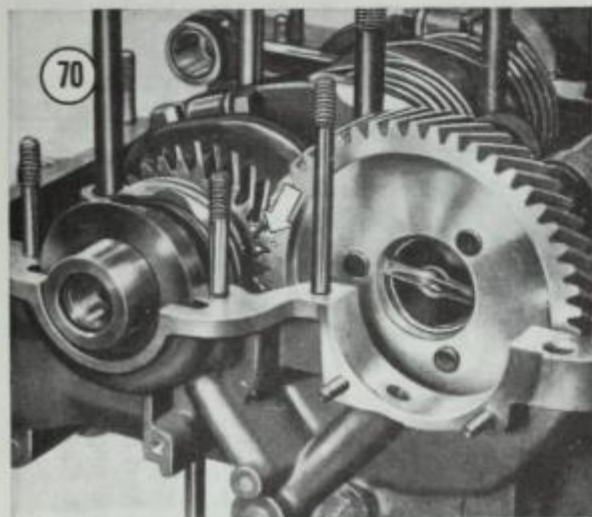
8. Slide the oil slinger onto the rear of the crankshaft so the concave side faces toward the rear.
9. Lift the crankshaft assembly by connecting rods #1 and #2. Place the crankshaft on the main bearing holders as shown in **Figure 69**. Connecting rods #3 and #4 must protrude through the corresponding cylinder holes.



10. Take the weight off one bearing at a time, rotate it until the pencil mark on the bearing is in its original position. There will be a slight click and the crankshaft should drop into place. Do this for each bearing, making sure each bearing seats in its dowel. Keep checking until none of the bearings rotate or move back and forth.
11. Turn the crankshaft until the center-punched marks on the timing gear face towards the camshaft bearings.

12. Coat camshaft journals and bearing surfaces with assembly lubricant.

13. Install the camshaft so that the camshaft gear tooth marked "O" fits between the crankshaft gear teeth marked with centerpunches. See **Figure 70**. This alignment is **very important** as it establishes the valve timing.



14. Install the camshaft end seal using VW sealing compound.

NOTE: On automatic stick shift cars, install the seal so the open end faces out. Others should be installed with the open end facing the camshaft.

15. Again check that the main bearings and cam bearings are seated. Lubricate all exposed crankshaft and camshaft journals and bearings.

16. Install new rubber seals over the crankcase studs on 1968-1972 engines. Late 1967 engines (from HO 398 526) also use these seals.

17. Spread VW sealing compound on the crankcase mating surfaces. Do not get any on the bearings.

18. Hold connecting rods #1 and #2 up. Tip the right case half over the left and slide it down on the studs.

19. Install some of the center washers and nuts hand tight. On 1967 engines from HO 230 323 to HO 398 525, 2 large center nuts on either side of bearing #2 have plastic rings pressed into them. Install these sealing nuts **without washers**. Before going any further, check that none of the cam followers (tappets) have slipped out.

20. Install the rest of the washers and nuts hand tight.

CAUTION: *The tightening sequence described in the next 4 steps is very important. Throughout the process, turn the crankshaft occasionally. If there is any binding STOP, take the case apart and find the trouble. Usually it is a main bearing off its dowel pin.*

21. Torque the 2 small nuts on either side of the camshaft end seal to 10 foot-pounds, then to 14 foot-pounds.

22. Torque the 2 large center nuts to 20 foot-pounds, then to 25 foot-pounds.

23. Torque all other large nuts to 20 foot-pounds, then to 25 foot-pounds.

24. Torque all remaining small nuts to 10 foot-pounds, then to 14 foot-pounds.

CRANKSHAFT

Removal

1. When the right half of the crankcase has been removed, lift the crankshaft out.

2. Remove the bearing inserts from the crankcase halves. Mark each on its back as it is removed so that it may be reinstalled in the same position.

Gear & Bearing Disassembly

Refer to **Figure 71** for the following procedure.

1. Slide the oil thrower and #4 main bearing off of the crankshaft.

2. Remove the snap ring on the rear of the crankshaft.

3. With a large gear puller, pull on the bottom of the innermost (timing) gear. Remove the distributor drive and timing gears. Save the 2 woodruff keys.

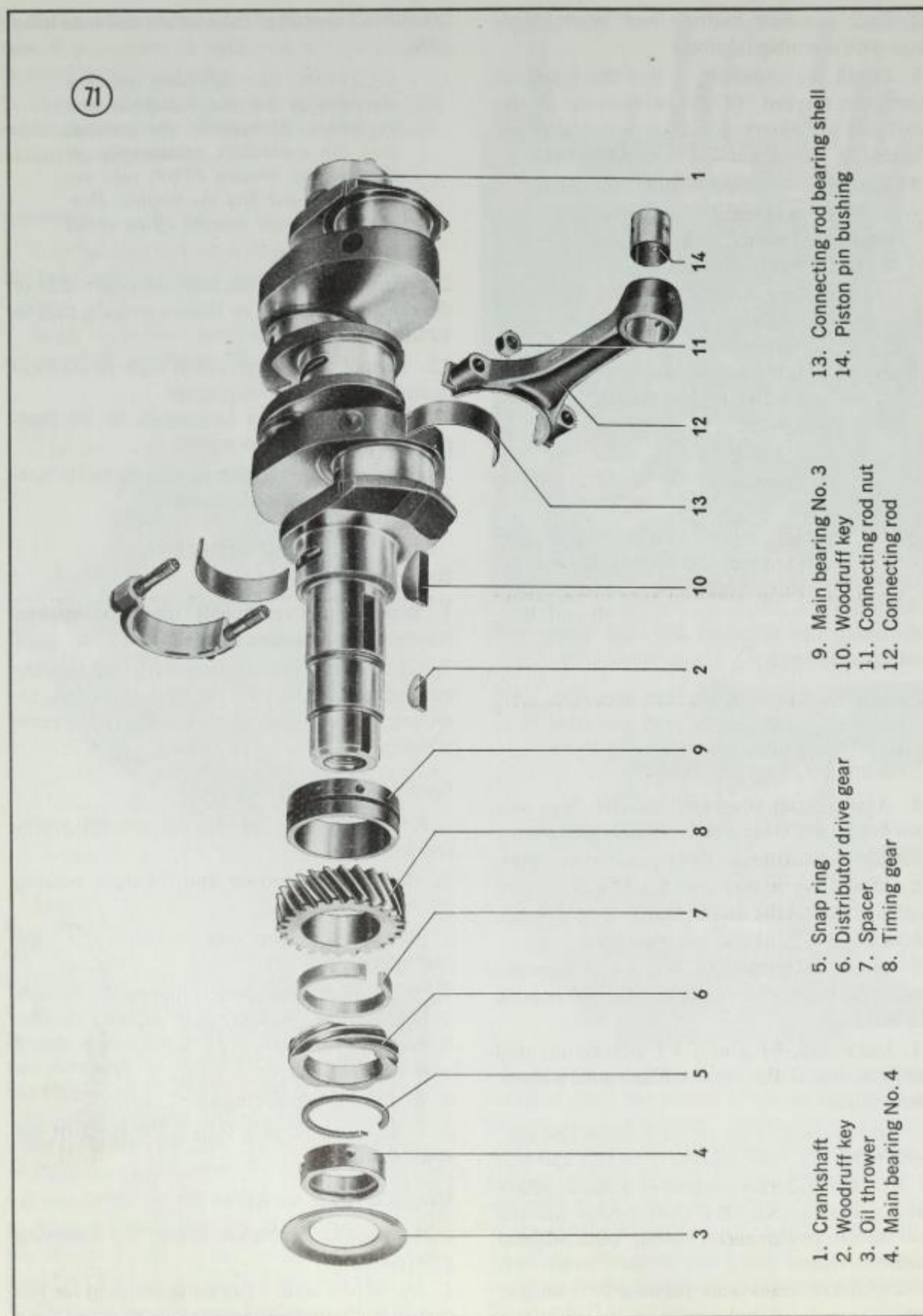
4. Slide #3 main bearing off.

5. Slide #1 main bearing off the front of the crankshaft.

Gear & Bearing Assembly

Refer again to **Figure 71** for the following procedure.

1. Fit #1, #3 and #4 main bearings in the left case half. Make sure the bearings fit properly in



the dowels. Mark their depth on the bearings to help position the bearings correctly on the crankshaft.

2. Wipe #3 bearing journal clean. Coat journal and #3 bearing with assembly lubricant. Note the hole in #3 bearing is offset. Slide #3 bearing on the crankshaft so the hole is close to the flywheel end of the crankshaft.

3. Lay the crankshaft vertically on a piece of wood with the flywheel end down.

4. Insert the large woodruff key in the crankshaft slot. Fit the timing gear over the crankshaft with the centerpunched timing marks facing up (towards the rear of the shaft). Align the timing gear slot with the woodruff key.

5. Tap lightly around the gear with a hammer and dull punch until the gear engages the woodruff key. The key must be flat, not canted in the slot.

6. Heat the timing gear with a small butane torch for a few minutes. Do not heat the bearing or the crankshaft. After 3 or 4 minutes, fit a length of 2" pipe over the crankshaft and drive the gear into position.

7. Slide the spacer ring in place and align its slot with both woodruff key slots.

8. Insert the small woodruff keys in the crankshaft. Slide the brass distributor drive gear over the crankshaft and align it with the woodruff key. Tap the gear down slightly over the woodruff key in the same manner as the timing gear.

9. Heat the distributor drive gear for one minute, then drive it down with a length of pipe until it is against the spacer ring.

10. Spread the snap ring with snap ring pliers and slide it over the crankshaft into the groove cut for it. Don't nick or scratch the #4 bearing journal.

11. Leave the #1 and #4 bearings off until ready to install the crankshaft. See Crankcase Assembly.

Inspection

1. Check connecting rod end play, then remove all connecting rods. Both procedures are described under Connecting Rod Removal later in this chapter.

2. Clean the crankshaft thoroughly with solvent. Clean the oil holes with rifle type brushes;

flush thoroughly and blow dry with air. Lightly oil all journal surfaces immediately to prevent rust.

3. Carefully inspect each journal for scratches, ridges, scoring, nicks, etc. Very small nicks and scratches may be removed with crocus cloth. More serious damage must be removed by grinding; a job for a machine shop.

4. If the surface finish on all journals is satisfactory, take the crankshaft to your dealer or local machine shop. They can check for out-of-roundness, taper and wear on the journals. They will also check crankshaft alignment and inspect for cracks.

Installation

Installation is simply a matter of setting the crankshaft in place after the crankcase is prepared. See Crankcase Assembly.

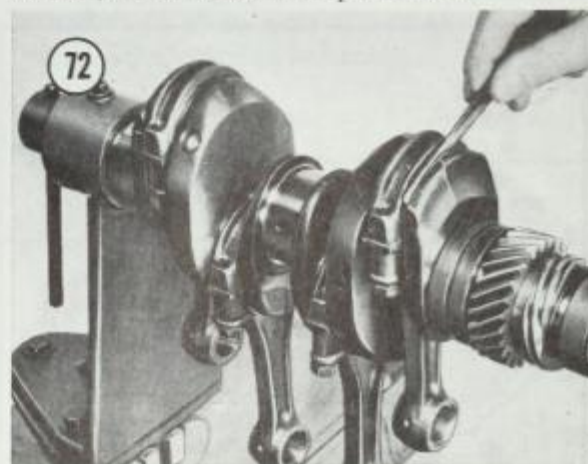
CONNECTING RODS

Removal

1. Remove the crankshaft from the engine. Clamp it down or have someone hold it.

2. File very small marks on each rod to indicate its position for reassembly. For example, make one mark on rod #1, two marks on rod #2, etc. The rods are numbered 3, 1, 4, 2 from the flywheel end of the crankshaft.

3. Insert a feeler gauge between the side of the rod and the crank throw (see **Figure 72**). If this gap (connecting rod end play) is greater than 0.016", mark the rod for replacement.



4a. On 1961-1966 (FO 451 420) engines, remove the connecting rod bolts and pull off the rod caps.

4b. On late 1966 (from FO 451 421) to 1972 engines, remove the connecting rod nuts only, and pull off the rod cap. **Do not** remove the bolts from the rod cap.

5. Remove the bearing inserts from the rod and cap. Mark the back of the insert with rod number for later inspection and reassembly. Do not mix up the bearings.

6. Install the caps on the rods to keep them together.

Inspection

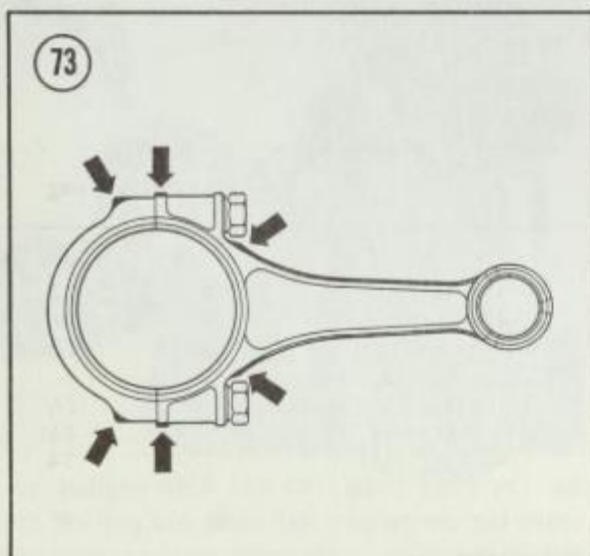
1. Discard any rods with excessive end play (see step 3 above).

2. Check each rod for obvious damage such as cracks or burns. If either bolt on a 1966-1972 rod cap is damaged, the entire rod must be replaced.

3. Check the piston pin bushing for wear or scoring. At room temperature a piston pin may slide through with light finger pressure. This does not indicate excessive wear, even though other pins are a drive fit, as long as there is no rocking (see Piston Removal, step 4).

4. Take the rods to a machine shop and have their alignment checked for twisting and bending.

5. Weigh each rod on a scale. They should be within $\frac{1}{3}$ oz. (10 grams) of each other. If not, find the lightest rod, and lighten the others as required to match it. You can remove as much as 8 grams total by filing or grinding metal away from the points indicated in **Figure 73**.



6. Examine the bearing inserts for wear, scoring, or burning. They are reusable if in good condition. Make a note of the bearing size (if any) stamped on the back of the insert if the bearing is to be discarded; a previous owner may have used undersize bearings.

Installation

1. Remove the rod cap from the rod and **discard the bolts** (1961-1966) **or nuts** (1966-1972). You must use new bolts or nuts. Do not remove the bolt from 1966 (FO 451 421)—1972 rods.

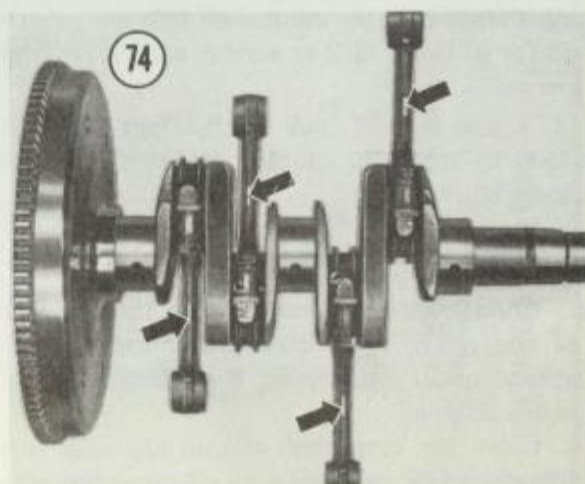
2. Carefully match the number on the side of each rod to its associated rod cap.

3. Install the bearing inserts in the rods and caps. Press the bearings in with your thumbs on the ends of the bearing. Don't press down on the middle of the bearing. Be sure that the tangs on the bearings fit into the notches on the rods and caps.

CAUTION: The bearings ends will extend slightly above the cap or rod. Do not file any part of the rod, cap or bearing for a different fit.

4. Oil the nuts and rod cap bolts lightly.

5. Cut a piece of Plastigage the width of the rod bearing. Assemble the rod cap on the crank throw for cylinder #3 (the one closest to the flywheel) with the Plastigage inserted between the rod cap and the crank throw. Make sure the forge mark on the rod faces up as shown in **Figure 74**. Tighten the nuts to 22-25 foot-pounds.



6. Remove the bearing cap and measure the width of the flattened Plastigage wire following the manufacturer's instructions. This is the bearing clearance. Compare it to the specifications for your engine. If it is not right, make sure that you have installed the proper bearings.

7. Remove the strip of Plastigage, coat the bearing and crank throw with assembly lubricant, and reassemble the rod on the corresponding crank throw.

8. Check that the rod rotates freely 180° through its own weight alone.

9. Measure the rod end play with a feeler gauge (see Removal, step 3). Compare with the specifications.

10. Repeat steps 5-9 for each rod. Be sure you assemble each rod with the forge mark up, and on the crank throw originally used for that rod. Also ensure that the rod and cap number are aligned.

CAMSHAFT

Removal

1. When the right half of the crankcase has been removed, lift the camshaft out.

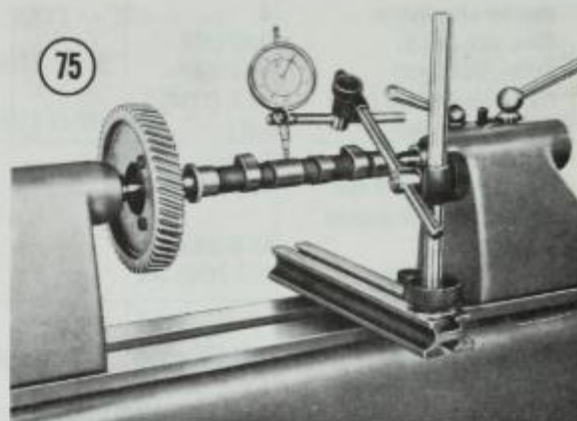
2. Remove the camshaft bearing inserts from 1966-1972 crankcase halves, and mark each on the back as it is removed so that it may be reinstalled in the same position.

Inspection

1. Check bearing journals and cam lobes for wear. The cam lobes should not be scored and the edges should be square. Slight damage may be removed with a silicon carbide oilstone. Use

100-120 grit initially, then polish with a 280-320 grit.

2. Check camshaft run-out at the center bearing. See **Figure 75**. Run-out must not exceed 0.0008".



3. Examine timing gear rivets, and check for gear looseness.

4. Check the timing gear teeth for wear and proper tooth contact.

5. Chamfer all edges of the bearing bores slightly to prevent seizure due to bearing pressure.

6. Check the bearing inserts for wear, scoring or burns. Replace if necessary.

7. Check the cam followers (tappets), which are removed when splitting the crankcase, for wear and scoring.

Installation

Installation is simply a matter of setting the camshaft in place after the crankcase is prepared. See Crankcase Assembly.

TIGHTENING TORQUES

	foot-pounds	mkg		foot-pounds	mkg
Connecting rods	22-25	3-3.5	Oil strainer nuts	5	0.7
Crankcase halves (large nuts)	25	3.5	Flywheel gland nut	217	30
Crankcase halves (small nuts)	14	2.0	Pressure plate bolts	18	2.5
Cylinder head nuts	23	3.2	Engine mounting bolts	22	3
Rocker shaft nuts	14-18	2-2.5	Torque converter to drive plate	18	2.5
Oil pump cover nuts	14	2.0	Crankshaft pulley	29-36	4-5
Oil drain plug	25	3.5	Spark plugs	22-29	3-4

SPECIFICATIONS, ENGINE — 1200, 1300

TYPE	1200 (1961-1965)		1300 (1966)	
	TOLERANCE (NEW)	WEAR LIMIT	TOLERANCE (NEW)	WEAR LIMIT
GENERAL				
Number of cylinders	4		4	
Bore, inch (mm)	3.03 (77)		3.03 (77)	
Stroke, inch (mm)	2.52 (64)		2.72 (69)	
Displacement, inch (mm)	72.7 (1192)		78.4 (1285)	
Compression ratio	7.0:1		7.3:1	
Firing order	1-4-3-2		1-4-3-2	
Output (SAE) bhp @ rpm	41.5 @ 3900		50 @ 4600	
Torque (SAE) foot-pounds @ rpm	65 @ 2400		69 @ 2600	
Weight (dry) lbs (kg)	237 (108)		244 (111)	
CYLINDERS				
Bore, inch (mm)	3.03 (77)		3.03 (77)	
Cylinder/piston clearance				
Out-of-round inch (mm)	0.0015-0.0019 (0.04-0.05)	0.008 (0.20)	0.0015-0.0019 (0.04-0.05)	0.008 (0.20)
inch (mm)	0.0004 (0.01)		0.0004 (0.01)	
Oversizes available mm	0.5, 1		0.5, 1	
PISTONS				
Material	light alloy		light alloy	
Weight, + (gray) grams	285-310		306-318	
— (brown) grams	280-302		298-310	
Permissible weight deviation in same engine	5	10 max	5	10 max
PISTON RINGS				
Number per piston	3		3	
Compression	2		2	
Oil Control	1		1	
Ring end gap				
Compression inch (mm)	0.012-0.018 (0.30-0.45)	0.035 (0.90)	0.012-0.018 (0.30-0.45)	0.035 (0.90)
Oil Control inch (mm)	0.010-0.016 (0.25-0.40)	0.037 (0.95)	0.010-0.016 (0.25-0.40)	0.037 (0.95)
Ring side clearance				
Top compression inch (mm)	0.0027-0.0035 (0.07-0.09)	0.0047 (0.12)	0.0027-0.0035 (0.07-0.09)	0.0047 (0.12)
Bottom compression inch (mm)	0.0019-0.0027 (0.05-0.07)	0.0039 (0.10)	0.0019-0.0027 (0.05-0.07)	0.0039 (0.10)
Oil Control inch (mm)	0.0012-0.0019 (0.03-0.05)	0.0039 (0.10)	0.0012-0.0019 (0.03-0.05)	0.0039 (0.10)
PISTON PINS				
Diameter inch (mm)	0.7871-0.7874 (19.996-20.000)		0.8658-0.8661 (21.996-22.000)	
Clearance in rod bushing inch (mm)	0.0004-0.0008 (0.01-0.02)	0.0016 (0.04)	0.0004-0.0008 (0.01-0.02)	0.0016 (0.04)
CRANKSHAFT				
Number of main bearings	4		4	
Main bearing journal diameter				
Bearings 1-3 inch (mm)	2.1640-2.1648 (54.97-54.99)		2.1640-2.1648 (54.97-54.99)	
Bearing 4 inch (mm)	1.5739-1.5748 (39.98-40.00)		1.5739-1.5748 (39.98-40.00)	
Connecting rod journal diameter, inch (mm)	2.1640-2.1648 (54.97-54.99)		2.1644-2.1653 (54.98-55.00)	
Main bearing clearances				
Bearings 1 & 3	0.0016-0.0047 (0.04-0.10)	0.007 (0.18)	0.0016-0.0047 (0.04-0.10)	0.007 (0.18)
Bearing 2	0.0011-0.0035 (0.03-0.09)	0.0066 (0.17)	0.0011-0.0035 (0.03-0.09)	0.0066 (0.17)
Bearing 4	0.0019-0.004 (0.05-0.10)	0.0074 (0.19)	0.0019-0.004 (0.05-0.10)	0.0074 (0.19)

SPECIFICATIONS, ENGINE — 1200, 1300 (Continued)

	1200 (1961-1965)		1300 (1966)	
	TOLERANCE (NEW)	WEAR LIMIT	TOLERANCE (NEW)	WEAR LIMIT
End play inch (mm)	0.0027-0.0051 (0.07-0.13)	0.006 (0.15)	0.0027-0.0051 (0.07-0.13)	0.006 (0.15)
Permissible out-of-round				
Main bearing journal inch (mm)		0.0011 (0.03)		0.0011 (0.03)
Connecting rod journal inch (mm)		0.0011 (0.03)		0.0011 (0.03)
CONNECTING RODS				
Weight deviation in same engine, grams	5	10 max	5	10 max
Weight + (black or gray) grams	507-515		592-600	
— (white or brown) grams	487-495		580-588	
Side clearance inch (mm)	0.004-0.016 (0.1-0.4)	0.028 (0.7)	0.004-0.016 (0.1-0.4)	0.028 (0.7)
Connecting rod bearing clearance inch (mm)	0.0008-0.0031 (0.02-0.08)	0.006 (0.15)	0.0008-0.0031 (0.02-0.08)	0.006 (0.15)
Piston pin bushing diameter, inch (mm)	0.7877-0.7880 (20.008-20.017)		0.8664-0.8667 (22.008-22.017)	
CAMSHAFT				
Number of bearings	3		3	
Bearing diameter inch (mm)	0.9837-0.9842 (24.99-25.00)		0.9837-0.9842 (24.99-25.00)	
Bearing clearance inch (mm)	0.0008-0.0019 (0.02-0.05)	0.0047 (0.12)	0.0008-0.0019 (0.02-0.05)	0.0047 (0.12)
End play inch (mm)	0.0016-0.0051 (0.04-0.13)	0.0063 (0.16)	0.0016-0.0051 (0.04-0.13)	0.0063 (0.16)
TIMING GEARS				
Backlash inch (mm)	0.0000-0.0019 (0.00-0.05)		0.0000-0.0019 (0.00-0.05)	
VALVES — INTAKE				
Head diameter inch (mm)	1.239 (31.5)		1.299 (33.0)	
Stem diameter inch (mm)	0.3125-0.3129 (7.94-7.95)	0.3109 (7.90)	0.3125-0.3129 (7.94-7.95)	
Valve guide inside diameter inch (mm)	0.3149-0.3156 (8.00-8.02)		0.3149-0.3156 (8.00-8.02)	
Valve face angle	45°		45°	
Valve seat angle	45°		45°	
VALVES — EXHAUST				
Head diameter inch (mm)	1.181 (30.0)		1.181 (30.0)	
Stem diameter inch (mm)	0.3114-0.3118 (7.91-7.92)	0.3109 (7.90)	0.3114-0.3118 (7.91-7.92)	0.3109 (7.90)
Valve guide inside diameter inch (mm)	0.3149-0.3156 (8.00-8.02)		0.3149-0.3156 (8.00-8.02)	
Valve face angle	45°		45°	
Valve seat angle	45°		45°	
VALVE SPRINGS				
Length inch (mm)	1.305 (33.4)		1.220 (31.0)	
@ load lbs (kg)	@ 90-103 lbs (40.8-46.8)		@ 117-135 (53.2-61.2)	
OIL SYSTEM				
Oil pressure (SAE 30 @ 158°F and 2500 rpm)	42 psi (3 kg/cm²)	28 psi (2 kg/cm²)	42 psi (3 kg/cm²)	28 psi (2 kg/cm²)
Oil pressure relief valve spring				
Length inch (mm)	0.928 (23.6)		0.928 (23.6)	
@ load lbs (kg)	@ 17 (7.75)		@ 17 (7.75)	
Oil pump				
Gear shaft end play (no gaskets) inch (mm)		0.004 (0.1)		0.004 (0.1)
Gear backlash inch (mm)	0.008 (0.0-0.2)		0.008 (0.0-0.2)	

SPECIFICATIONS, ENGINE — 1500, 1600

1500 (1967-1969)		1600 (1970-1972)		
TYPE	TOLERANCE (NEW)	WEAR LIMIT	TOLERANCE (NEW)	WEAR LIMIT
GENERAL				
Number of cylinders	4		4	
Bore, inch (mm)	3.27 (83)		3.36 (85.5)	
Stroke, inch (mm)	2.72 (69)		2.72 (69)	
Displacement, inch (mm)	91.1 (1493)		96.6 (1584)	
Compression ratio	7.5:1		7.5:1 ¹ ± 7.3:1 ²	
Firing order	1-4-3-2		1-4-3-2	
Output (SAE) bhp @ rpm	53 @ 4200		57 @ 4400 ¹ 60 @ 4400 ²	
Torque (SAE) foot-pounds @ rpm	78 @ 2600		81.7 @ 3000	
Weight (dry) lbs (kg)	250 (114)		264 (120)	
CYLINDERS				
Bore, inch (mm)	3.27 (83)		3.36 (85.5)	
Cylinder/piston clearance inch (mm)	0.0015-0.0019 (0.04-0.05)	0.008 (0.20)	0.0015-0.0019 (0.04-0.05)	0.008 (0.20)
Out-of-round inch (mm)	0.0004 (0.01)		0.0004 (0.01)	
Oversizes available mm	0.5, 1		0.5, 1	
PISTONS				
Material	light alloy		light alloy	
Weight, + (gray) grams	378-388		378-388	
— (brown) grams	370-380		370-380	
Permissible weight deviation in same engine	5	10 max	5	10 max
PISTON RINGS				
Number per piston	3		3	
Compression	2		2	
Oil Control	1		1	
Ring end gap				
Compression inch (mm)	0.012-0.018 (0.30-0.45)	0.035 (0.90)	0.012-0.018 (0.30-0.45)	0.035 (0.90)
Oil Control inch (mm)	0.010-0.016 (0.25-0.40)	0.037 (0.95)	0.010-0.016 (0.25-0.40)	0.037 (0.95)
Ring side clearance				
Top compression inch (mm)	0.0027-0.0035 (0.07-0.09)	0.0047 (0.12)	0.0027-0.0035 (0.07-0.09)	0.0047 (0.12)
Bottom compression inch (mm)	0.0019-0.0027 (0.05-0.07)	0.0039 (0.10)	0.0019-0.0027 (0.05-0.07)	0.0039 (0.10)
Oil Control in (mm)	0.0012-0.0019 (0.03-0.05)	0.0039 (0.10)	0.0012-0.0019 (0.03-0.05)	0.0039 (0.10)
PISTON PINS				
Diameter inch (mm)	0.8658-0.8661 (21.996-22.000)		0.8658-0.8661 (21.996-22.000)	
Clearance in rod bushing inch (mm)	0.0004-0.0008 (0.01-0.02)	0.0016 (0.04)	0.0004-0.0008 (0.01-0.02)	0.0016 (0.04)
CRANKSHAFT				
Number of main bearings	4		4	
Main bearing journal diameter				
Bearings 1-3 inch (mm)	2.1640-2.1648 (54.97-54.99)		2.1640-2.1648 (54.97-54.99)	
Bearing 4 inch (mm)	1.5739-1.5748 (39.98-40.00)		1.5739-1.5748 (39.98-40.00)	
Connecting rod journal diameter, inch (mm)	2.1644-2.1653 (54.98-55.00)		2.1644-2.1653 (54.98-55.00)	
Main bearing clearances				
Bearings 1 & 3		0.007 (0.18)		0.007 (0.18)
Bearing 2		0.0066 (0.17)		0.0066 (0.17)
Bearing 4		0.0074 (0.19)		0.0074 (0.19)

¹ 1970 ² 1971 ³ 1972

SPECIFICATIONS, ENGINE — 1500, 1600 (Continued)

	1500 (1967-1969)		1600 (1970-1972)	
	TOLERANCE (NEW)	WEAR LIMIT	TOLERANCE (NEW)	WEAR LIMIT
End play inch (mm)	0.0027-0.0051 (0.07-0.13)	0.006 (0.15)	0.0027-0.0051 (0.07-0.13)	0.006 (0.15)
Permissible out-of-round				
Main bearing journal inch (mm)		0.0011 (0.03)		0.0011 (0.03)
Connecting rod journal inch (mm)		0.0011 (0.03)		0.0011 (0.03)
CONNECTING RODS				
Weight deviation in same engine, grams	5	10 max	5	10 max
Weight + (black or gray) grams	592-600			
— (white or brown) grams	580-588			
Side clearance inch (mm)	0.004-0.016 (0.1-0.4)	0.028 (0.7)		0.028 (0.7)
Connecting rod bearing clearance inch (mm)	0.0008-0.0031 (0.02-0.08)	0.006 (0.15)		0.006 (0.15)
Piston pin bushing diameter, inch (mm)	0.8664-0.8667 (22.008-22.017)		0.8664-0.8667 (22.008-22.017)	
CAMSHAFT				
Number of bearings	3		3	
Bearing diameter inch (mm)	0.9837-0.9842 (24.99-25.00)		0.9837-0.9842 (24.99-25.00)	
Bearing clearance inch (mm)	0.0008-0.0019 (0.02-0.05)	0.0047 (0.12)	0.0008-0.0019 (0.02-0.05)	0.0047 (0.12)
End play inch (mm)	0.0016-0.0051 (0.04-0.13)	0.0063 (0.16)	0.0016-0.0051 (0.04-0.13)	0.0063 (0.16)
TIMING GEARS				
Backlash inch (mm)	0.0000-0.0019 (0.00-0.05)		0.0000-0.0019 (0.00-0.05)	
VALVES — INTAKE				
Head diameter inch (mm)	1.397 (35.5)		1.397 (35.5)	
Stem diameter inch (mm)	0.3125-0.3129 (7.94-7.95)	0.3109 (7.90)	0.3125-0.3129 (7.94-7.95)	0.3109 (7.90)
Valve guide inside diameter inch (mm)	0.3149-0.3156 (8.00-8.02)		0.3149-0.3156 (8.00-8.02)	
Valve face angle	45°		45°	
Valve seat angle	45°		45°	
VALVES — EXHAUST				
Head diameter inch (mm)	1.259 (32.0)		1.259 (32.0)	
Stem diameter inch (mm)	0.3114-0.3118 (7.91-7.92)	0.3109 (7.90)	0.3114-0.3118 (7.91-7.92)	0.3109 (7.90)
Valve guide inside diameter inch (mm)	0.3149-0.3156 (8.00-8.02)		0.3149-0.3156 (8.00-8.02)	
Valve face angle	45°		45°	
Valve seat angle	45°		45°	
VALVE SPRINGS				
Length inch (mm)	1.220 (31.0)		1.220 (31.0)	
@ load lbs (kg)	@ 117-135 (53.2-61.2)		@ 117-135 (53.2-61.2)	
OIL SYSTEM				
Oil pressure (SAE 30 @ 158°F and 2500 rpm)	42 psi (2 kg/cm²)	28 psi (2 kg/cm²)	42 psi (2 kg/cm²)	28 psi (2 kg/cm²)
Oil pressure relief valve spring				
Length inch (mm)	0.928 (23.6)		0.928 (23.6)	
@ load lbs (kg)	@ 17 (7.75)		@ 17 (7.75)	
OIL PUMP				
Gear shaft end play (no gaskets) inch (mm)		0.004 (0.1)		0.004 (0.1)
Gear backlash inch (mm)	0.008 (0.0-0.2)		0.008 (0.0-0.2)	

CHAPTER FIVE

COOLING, HEATING, AND EXHAUST

The cooling, heating, and exhaust systems on a Beetle or Karmann Ghia are very closely related. A large fan on the front end of the generator provides cooling air to the engine. Sheet metal cover plates direct the air from the fan housing around the cylinders and cylinder heads. Cooling air temperature is thermostatically controlled.

When the engine is cold, an air control ring limits the intake of cold air to the fan housing on 1961-1964 models. On 1965-1972 models, air control flaps limit the outflow of cold air from the fan housing to the engine. Both methods permit rapid engine warm up in any weather by limiting the cooling effect of the fan. Once the engine is warm, the thermostat permits the maximum volume of cool air to be admitted.

Two different heating systems are used from 1961-1972. On 1961 and 1962 models, heated air, which cooled the engine, is directed into the passenger area. This system should be watched closely for exhaust leaks, since dangerous carbon monoxide could be blown directly into the passenger area. If you smell exhaust fumes, open the windows and investigate immediately.

Heaters on 1963-1972 models differ importantly from the earlier system. Large hoses direct fresh air from the fan housing through heat exchangers and into the passenger area. Exhaust gases pass through a separate area in

the heat exchanger and warm the air. There is less chance of exhaust leaks contaminating the heated air.

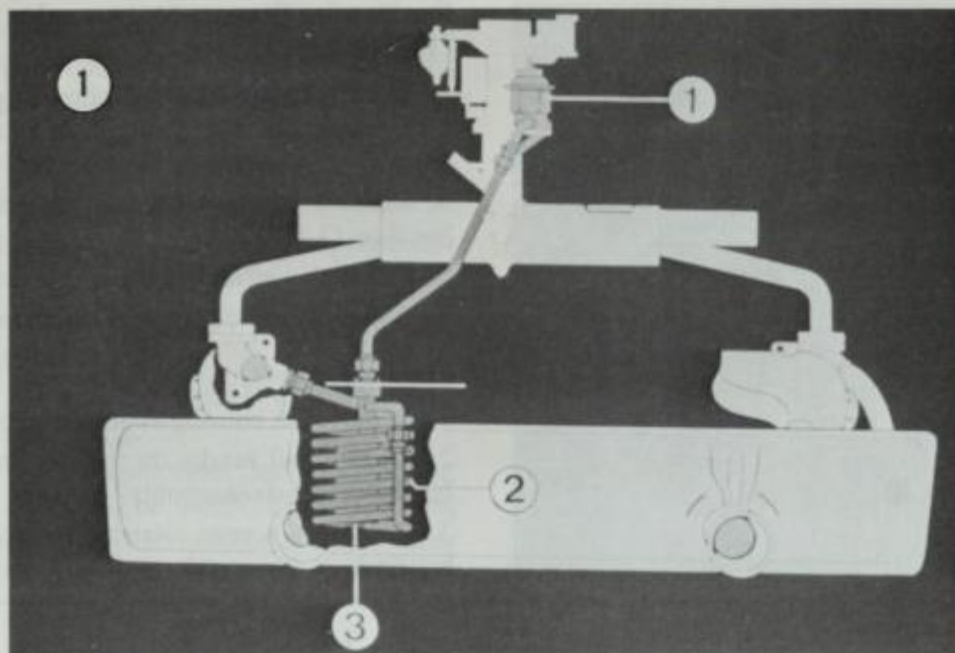
The exhaust system is very straightforward. On 1961 and 1962 cars, exhaust gases pass through exhaust pipes to the muffler. On 1963-1972 cars, exhaust gases pass through heat exchangers to the muffler. A portion of the exhaust gases are tapped off through the preheater pipe to warm the intake manifold.

1972 automatic stick shift cars for California have a unique exhaust recirculation system to cut nitrogen oxides in the exhaust gases. **Figures 1** shows the system. Exhaust gases pass from a special take-off point on the muffler into the cooling coil (2) and filter (3). During partial engine loads, intake manifold vacuum opens the recirculation valve which admits the cooled, clean exhaust gases into the intake manifold. Addition of this gas lowers combustion chamber temperatures, thereby reducing the emission of oxides of nitrogen in the exhaust.

COOLING SYSTEM

Fan Housing Removal/Installation

This procedure permits removal while the engine is installed. If the engine is not installed, the fan housing is removed by performing steps 10 through 12 of Engine Disassembly.



1. Remove the fan belt as described in Chapter Two. Do not attempt to pry the belt over the pulley.

2. Disconnect the negative battery cable.

3. Remove the rear hood as described in Chapter Thirteen.

4. Remove heater hoses between fan housing and heat exchangers (1963-1972).

5a. On 1961-1966 cars, disconnect the small wire from the voltage regulator (mounted on generator) and mark it 61. Disconnect the large wire(s) and mark it B + (51). Disconnect and mark ignition coil wires.

5b. On 1967-1972 cars, disconnect 3 wires from the generator. Mark them with labels as marked on the generator.

6. Disconnect the oil pressure switch wire. The oil pressure switch is located on the crankcase near the distributor.

7. Remove the carburetor following the procedure in Chapter Six.

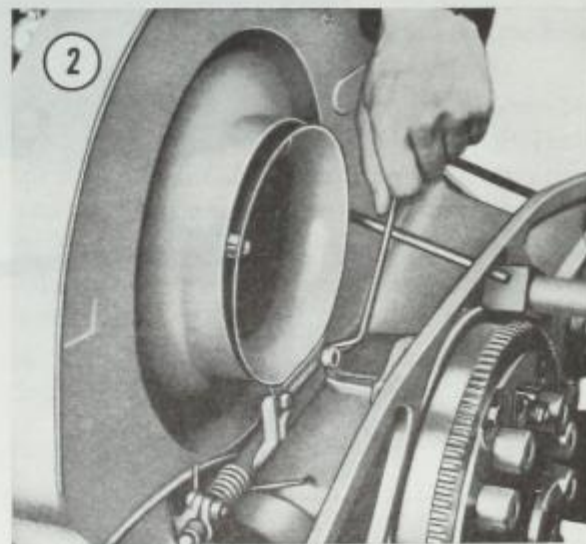
8. Pull the accelerator cable out the front of the fan housing.

9. Remove the distributor cap and pull wires off the spark plugs.

10. Remove strap securing generator to its pedestal.

11. Remove screws on both sides of fan housing.

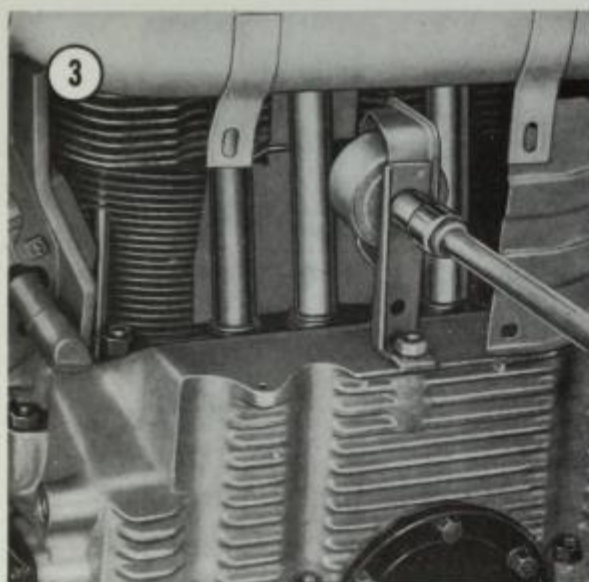
12a. On 1961-1964 models, unhook the air control ring spring and remove bolts securing the ring to the fan housing. See **Figure 2**.



12b. On 1965-1972 models, remove the air control thermostat screw (see **Figure 3**) and unscrew the thermostat from the control rod.

13. Pull the fan housing off, complete with generator and fan.

14. Installation is the reverse of these steps. Adjust the air control ring (1961-1964) or thermostat (1965-1972) as described later in this chapter.



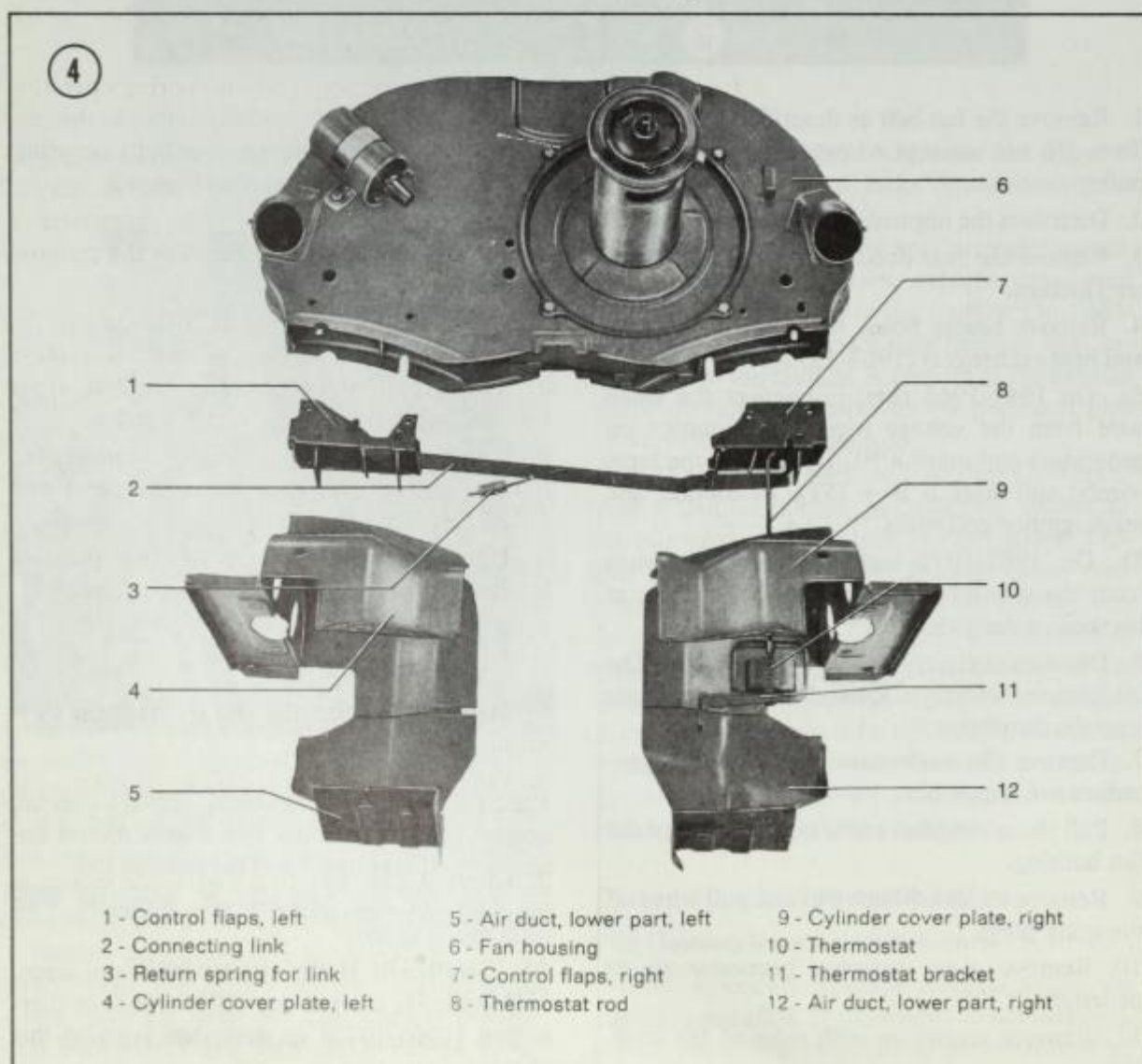
Fan Housing Disassembly/Assembly (1965-1972)

Refer to **Figure 4** for the following procedure.

1. Unhook the connecting link return spring (3).
2. Remove 8 screws securing the control flap housings (1 & 7).
3. Pull both control flap housings out.
4. Assembly is the reverse of disassembly.

Fan Removal

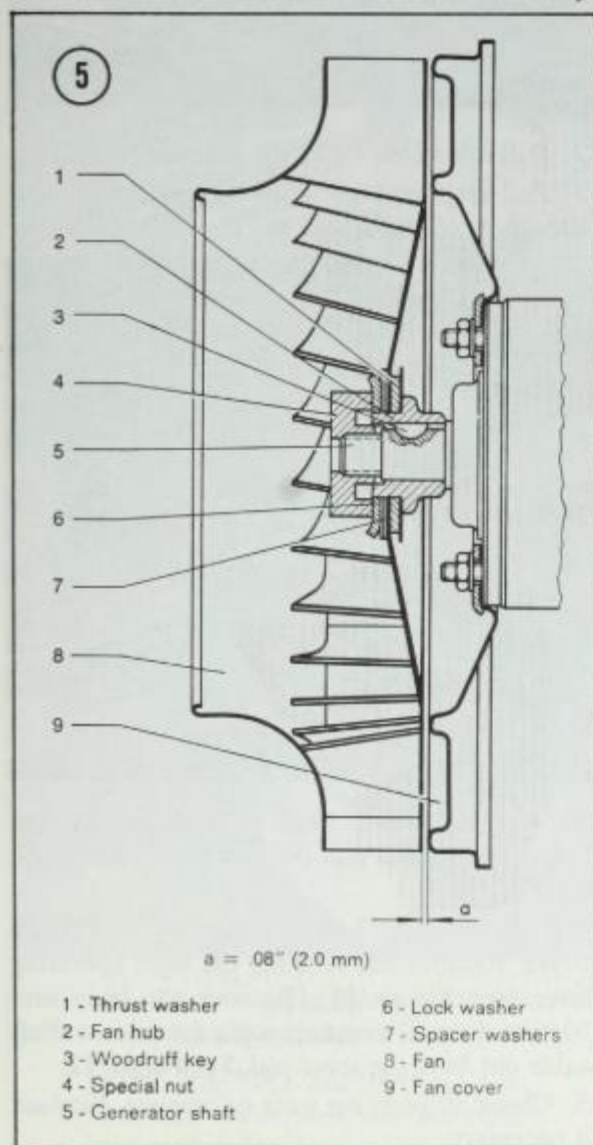
1. Remove fan housing as described previously.
2. Make small marks on the fan housing and fan cover to aid reassembly.
3. Remove 4 screws securing fan cover to fan housing.



4. Remove generator and fan assembly.
5. Remove the fan nut.
6. Pull off the fan, thrust washer, shims, and hub.

Fan Installation

1. Place the fan hub on the generator shaft. Be sure the woodruff key is properly seated.
2. Insert shims.
3. Place fan in position.
4. Install fan nut and tighten to 40-47 foot-pounds (5.5-6.5 mkg).
5. Check the distance from fan to cover (a, **Figure 5**). It should be 0.08" (2.0mm). If not, remove the nut; vary the number of shims under the thrust washer. Install the thrust washer, any



unused shims, and retorque the nut. Measure "a" again. Readjust if necessary.

6. Install fan cover assembly in the fan housing.
7. Install the fan housing.
8. Adjust fan belt tension. See Chapter Two.

CAUTION: Polarize the generator as described in Chapter Seven before connecting any generator or voltage regulator wires. Otherwise the voltage regulator can be seriously damaged.

Air Control Ring Adjustment (1961-1964)

If the engine is installed, warm the engine and check that the upper edge of the air control is about 0.78" (20mm) from the fan housing (see Figure 2). If not, adjust as described below. Note this procedure applies to engines which are not yet installed also.

1. Loosen the clamp bolt on the ring operating lever (see 1, Figure 2).

2a. If the engine is installed, warm the engine until the upper end of the thermostat touches the upper stop on the bracket. The thermostat is mounted on the right side between the pushrod tubes for cylinders 1 and 2.

2b. If the engine is not installed, remove the bolt securing the thermostat to its bracket. Have an assistant lift the thermostat until its upper end touches the upper stop on the bracket.

3. Pull the air control ring away from the fan housing about 0.78" (20mm) as measured with a steel rule. See Figure 2.

4. Tighten the clamp bolt on the ring operating lever while holding the ring in this position.

NOTE: Remaining steps apply only if engine is not installed.

5. Install and tighten the bolt securing the thermostat to its bracket.

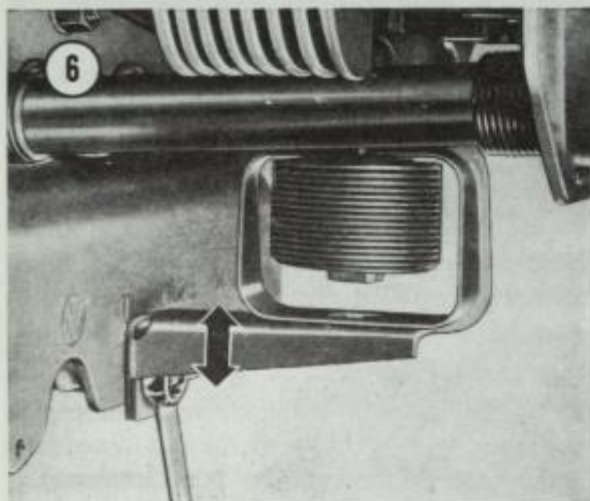
6. Ensure the air control ring rests against the rubber stop on the fan housing with slight preload.

7. Check adjustment again once the engine is installed and warmed up.

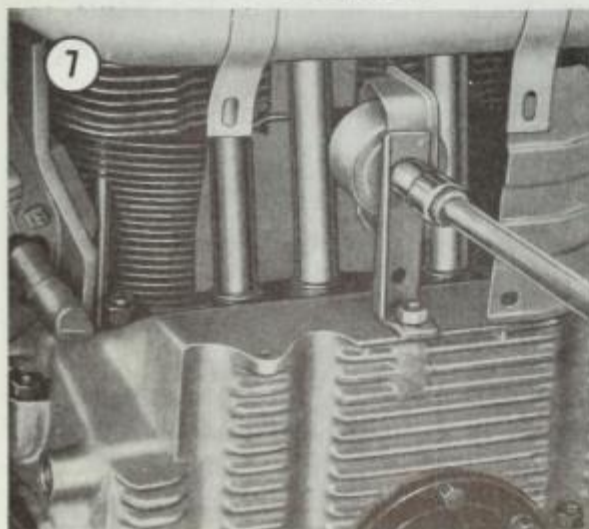
Air Control Thermostat Adjustment (1965-1972)

This procedure may be performed with the engine installed or not installed.

1. If thermostat has been removed, screw it onto the connecting rod (8, Figure 4).
2. Loosen nut securing the thermostat bracket to the crankcase.
3. Open the control flaps with connecting rod.
4. Move the thermostat bracket in the slot until the upper end of the thermostat touches the upper part of the bracket. See **Figure 6**. Tighten the bracket nut.



5. Move the thermostat back and forth to ensure that the flaps work.
6. Install and tighten the bolt securing the thermostat to the bracket. See **Figure 7**.



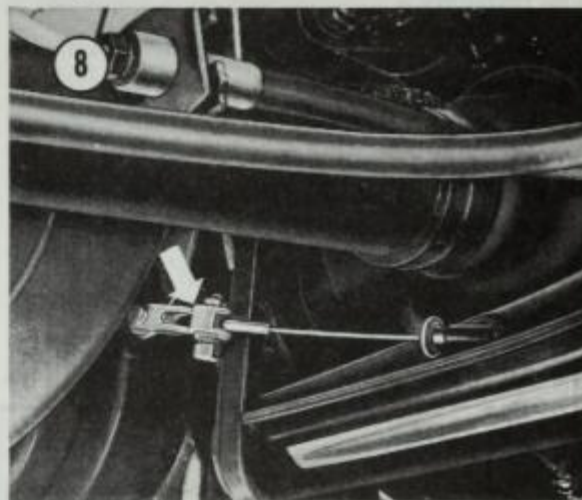
HEATING SYSTEM

Heater Cable Replacement

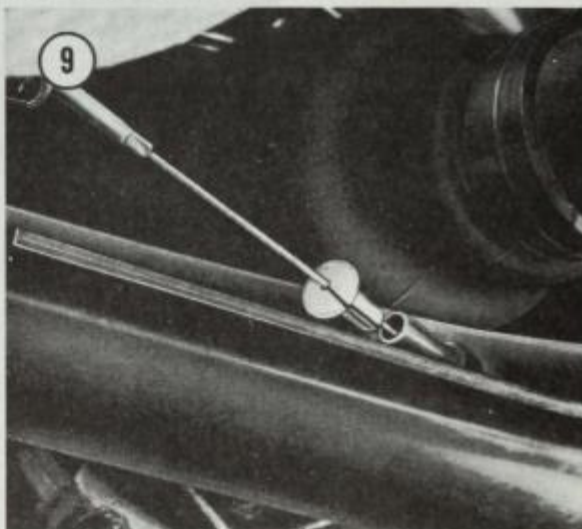
Two cables are permanently joined at the lever end so that both heater flaps operate simul-

taneously. The cables are replaced together, not individually.

1. Loosen the clamp nuts securing the cable ends to the heat exchanger or junction box lever. See **Figure 8**.



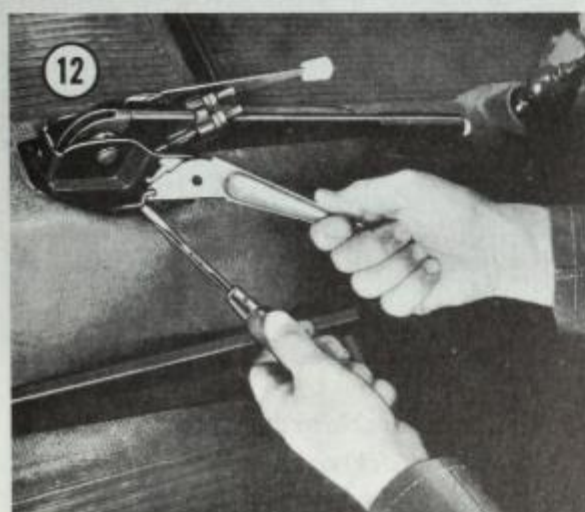
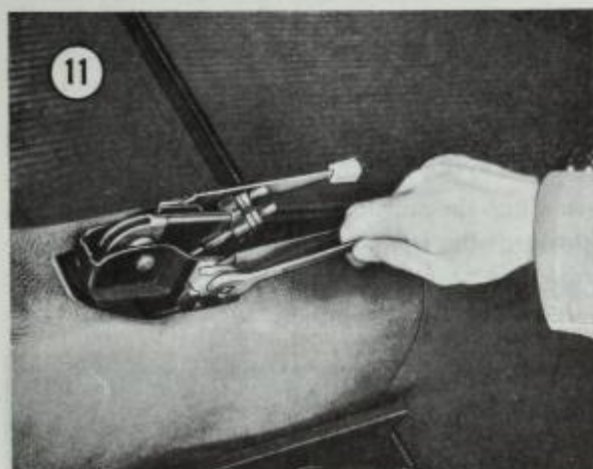
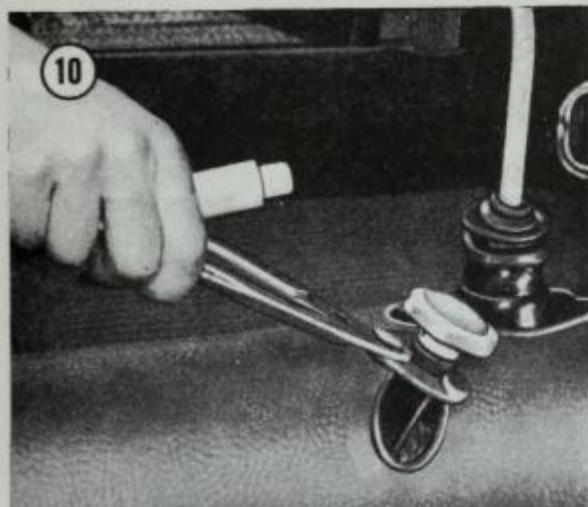
2. Pull cable ends out of the clamps.
3. Pull sealing plugs out of the guide tubes and slide them off the cables. See **Figure 9**.



- 4a. On 1961 and 1962 models, remove the threaded cap and pull out the knob with cable. See **Figure 10**.

- 4b. On 1963-1972 models, remove hand brake cover. Remove nut securing the right operating lever (see **Figure 11**). Remove the lever and friction discs. Disconnect cable from lever. Pull cable out from the lever end. See **Figure 12**.

5. Check all parts for wear or damage. Replace if necessary.



6. Grease the new cable lightly with universal grease and push the ends into the guide tubes.

NOTE: On 1961 and 1962 models, the longer cable goes into the right hand guide tube.

7a. On 1961 and 1962 models, hook the new cable onto the heater control knob assembly. Turn the knob counterclockwise to the stop, then 3 turns clockwise before installation. Install the heater control knob assembly.

7b. On 1963-1972 models, hook cable on operating lever. Install the lever with friction discs. Install the hand brake cover.

8. Install sealing plugs on cables and push them into the guide tubes.

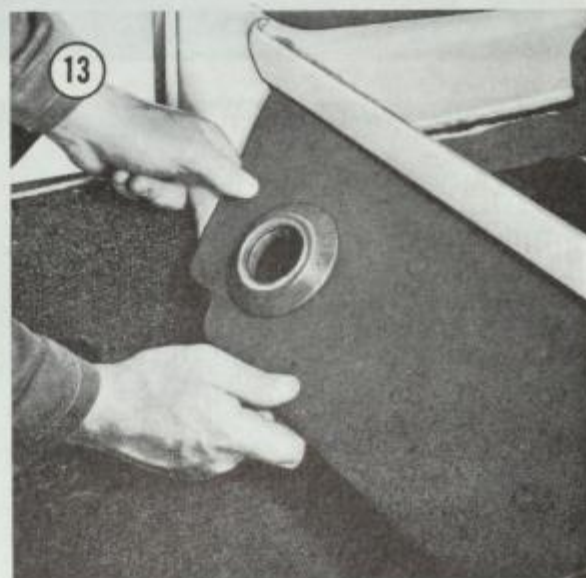
9. Clamp cables to heater flap clamps. Ensure the flaps open and close fully when operating the lever.

NOTE: You can alter the force required to operate the heater flaps by adjusting the tightness of the mounting nut.

Rear Footwell Cable Replacement (1963-1972)

Two cables are permanently joined at the lever end so that both footwell flaps operate simultaneously. The cables are replaced together, not individually.

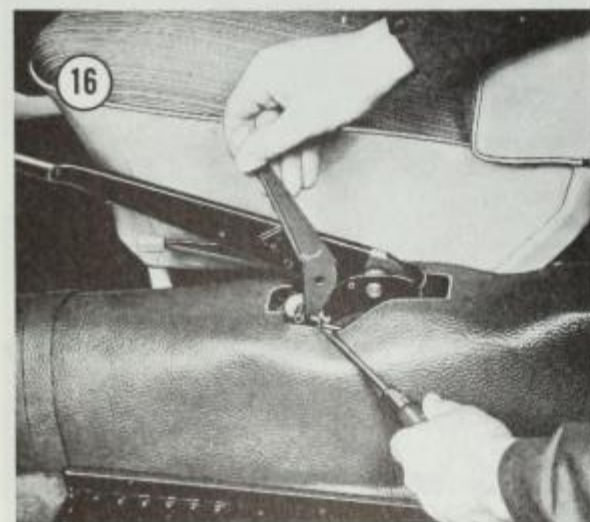
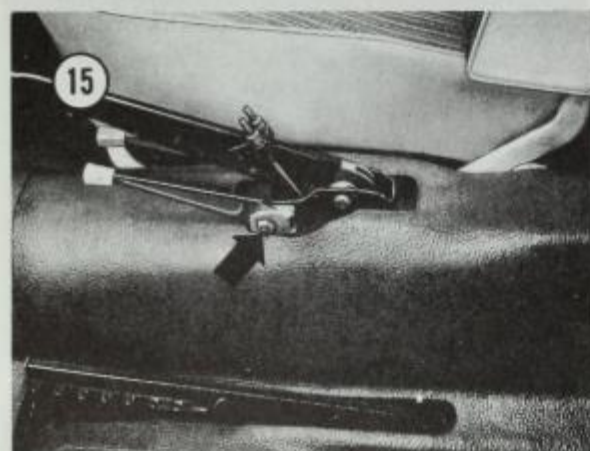
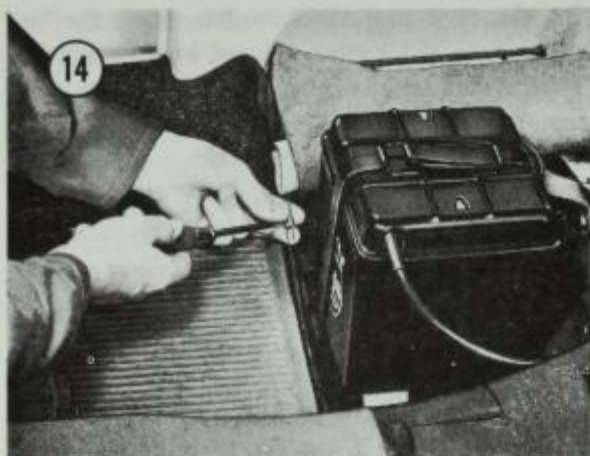
1. Remove rear seat cushion (see Chapter Thirteen) and kick boards (see **Figure 13**).



2. Loosen screws at each cable end clamp. See **Figure 14**. Disconnect cable ends.

3. Remove the handbrake cover. Remove nut securing the left operating lever (see **Figure 15**). Remove the lever and friction washers.

4. Disconnect cable from lever. See **Figure 16**. Pull cable out from the lever end.



5. Check all parts for wear or damage. Replace if necessary.
6. Grease the new cable lightly with universal grease and push the ends into the guide tubes.

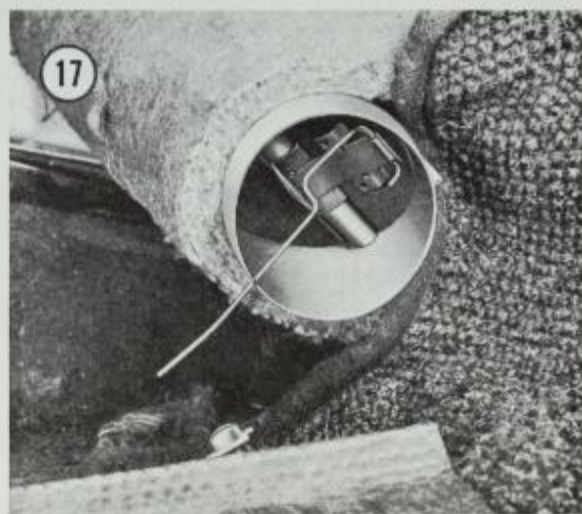
NOTE: The longer end goes into the lower guide tube.

7. Hook cable on operating lever, and install the lever with friction discs. Install the hand brake cover.
8. Connect the cable ends to the flaps with the clamp screws.
9. Install the kick boards. Make sure that the rubber rings fit tightly against the heater outlets. Install the rear seat.
10. Check the operation of both flaps.

NOTE: You can alter the force required to operate the lever by adjusting the tightness of the mounting nut.

Rear Footwell Flap Replacement

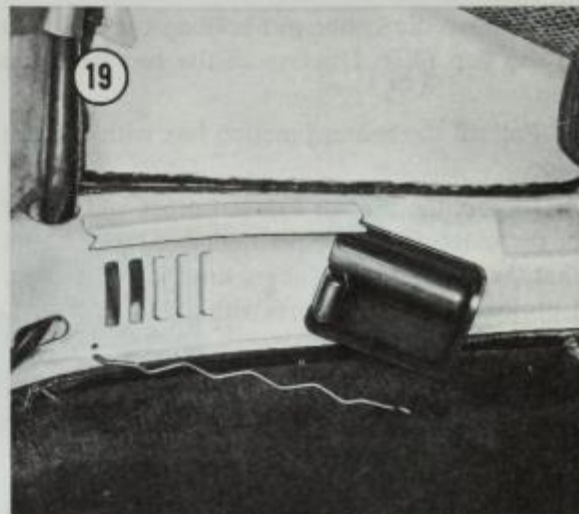
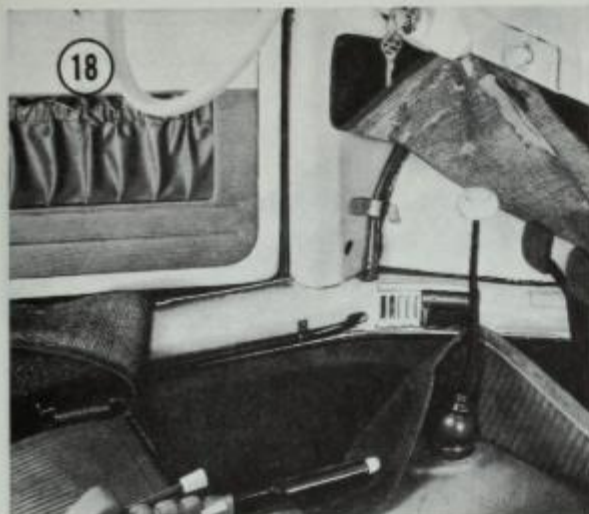
1. Remove rear seat cushion (see Chapter Thirteen) and kick boards (see Figure 13).
2. Loosen screw at cable end clamp. See Figure 14. Disconnect cable end.
3. Hold front edge of flap and pull it off the shaft. Do not pull the wire, which is easily bent.
4. Snap the new flap onto its shaft with the wire towards the front as shown in **Figure 17**. Move the flap several times with the wire to ensure that it moves smoothly.



5. Connect the cable to the clamp.
6. Install the kickboard so the rubber ring fits tightly against the heater outlet. Install the rear seat cushion.

Front Heater Outlet Removal/Installation

1. Pull the carpeting away from the warm air outlet. See **Figure 18**.
2. Disconnect spring wire at one end.



3. Slide outlet cover forward until it comes out. See **Figure 19**.

4. Installation is the reverse of these steps. Glue the carpeting lightly with an adhesive such as contact cement.

Heater Junction Box Replacement (1961-1962)

Refer to **Figure 20** for the following procedures.

1. Remove the muffler as described later in this chapter.

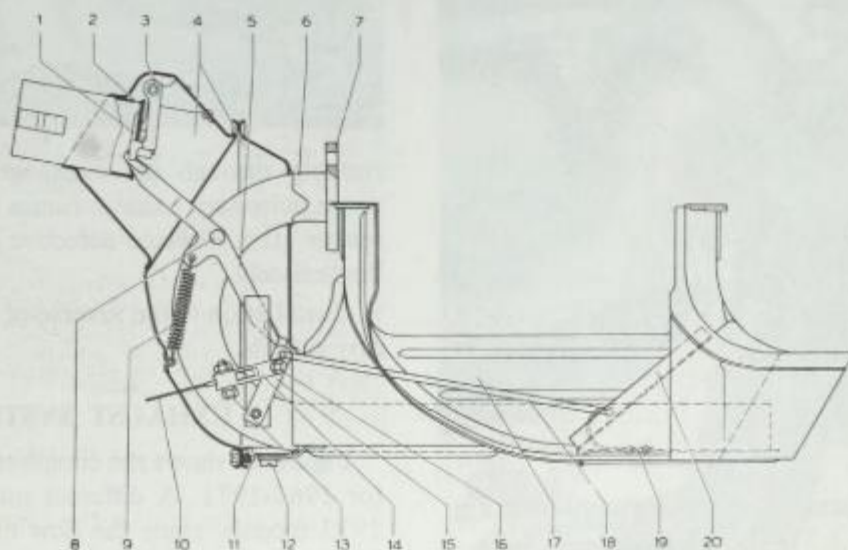
2. Disconnect the flexible heater pipe from the front of the junction box.

3. Loosen the clamp nut (13, **Figure 20**) and disconnect the control cable.

4. Remove nuts from the exhaust flange.

5. Remove screw (12) securing the junction box to the heater channel.

20



- 1 - Heat control valve
- 2 - Gasket
- 3 - Heat control valve lever
- 4 - Heating junction box
- 5 - Toggle lever
- 6 - Exhaust pipe
- 7 - Flange

- 8 - Toggle lever seat
- 9 - Return spring
- 10 - Heating control cable
- 11 - Flange screws
- 12 - Slotted screw
- 13 - Clamping device
- 14 - Link

- 15 - Operating lever
- 16 - C-washer
- 17 - Heating channel
- 18 - Connector rod
- 19 - Heat control sheet
- 20 - Heat control sheet stop rail

6. Remove the cotter pin holding the rod (12) to the flap (13). Disconnect the rod from the flap.

7. Pull off the heater junction box with exhaust pipe.

8. Inspect the muffler exhaust pipes and heater boxes carefully for leaks and damage. Ensure that the exhaust pipe flanges are clean and even. Lubricate all moving parts with graphite.

WARNING: Leaks in the exhaust and heating system can cause dangerous carbon monoxide levels in the passenger area.

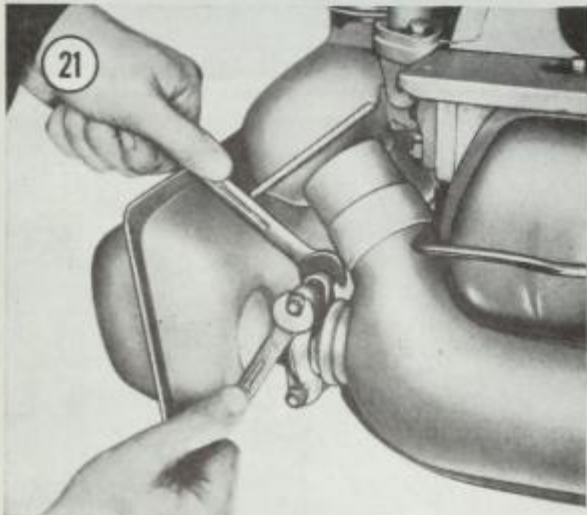
9. Installation is the reverse of these steps. Use new gaskets. See Warning above.

Heat Exchanger Replacement (1963-1972)

1. Disconnect hoses between fan housing and heat exchangers.

2. Remove rear engine coverplate if engine is installed.

3. Remove clamps between the muffler and heat exchanger (see Figure 21).



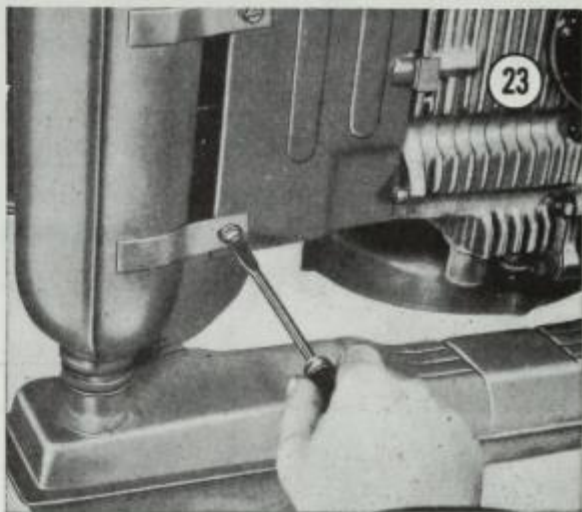
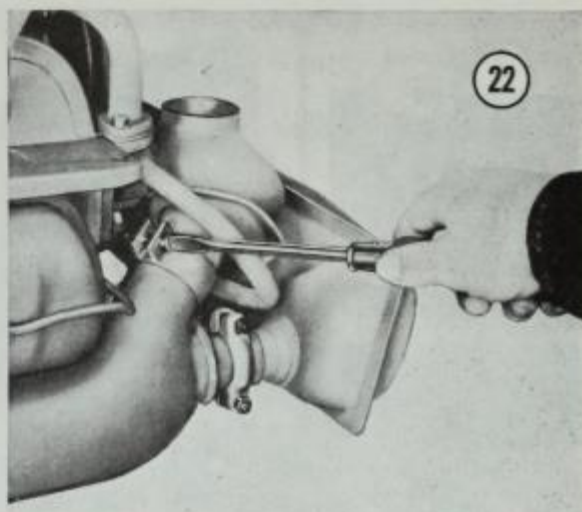
4. Remove warm air channel clamps. See Figure 22.

5. Remove nuts on the front exhaust port flange of the heat exchanger.

6. Remove screws on cover plate below fan pulley. See Figure 23.

7. Push heat exchanger forward until it clears the exhaust port studs, then remove it.

8. Check carefully for leaks in the exhaust pipe



running through the exchanger. Leaks could cause poisonous exhaust fumes to enter the passenger area. Replace defective heat exchangers immediately.

9. Installation is the reverse of these steps. Use new gaskets.

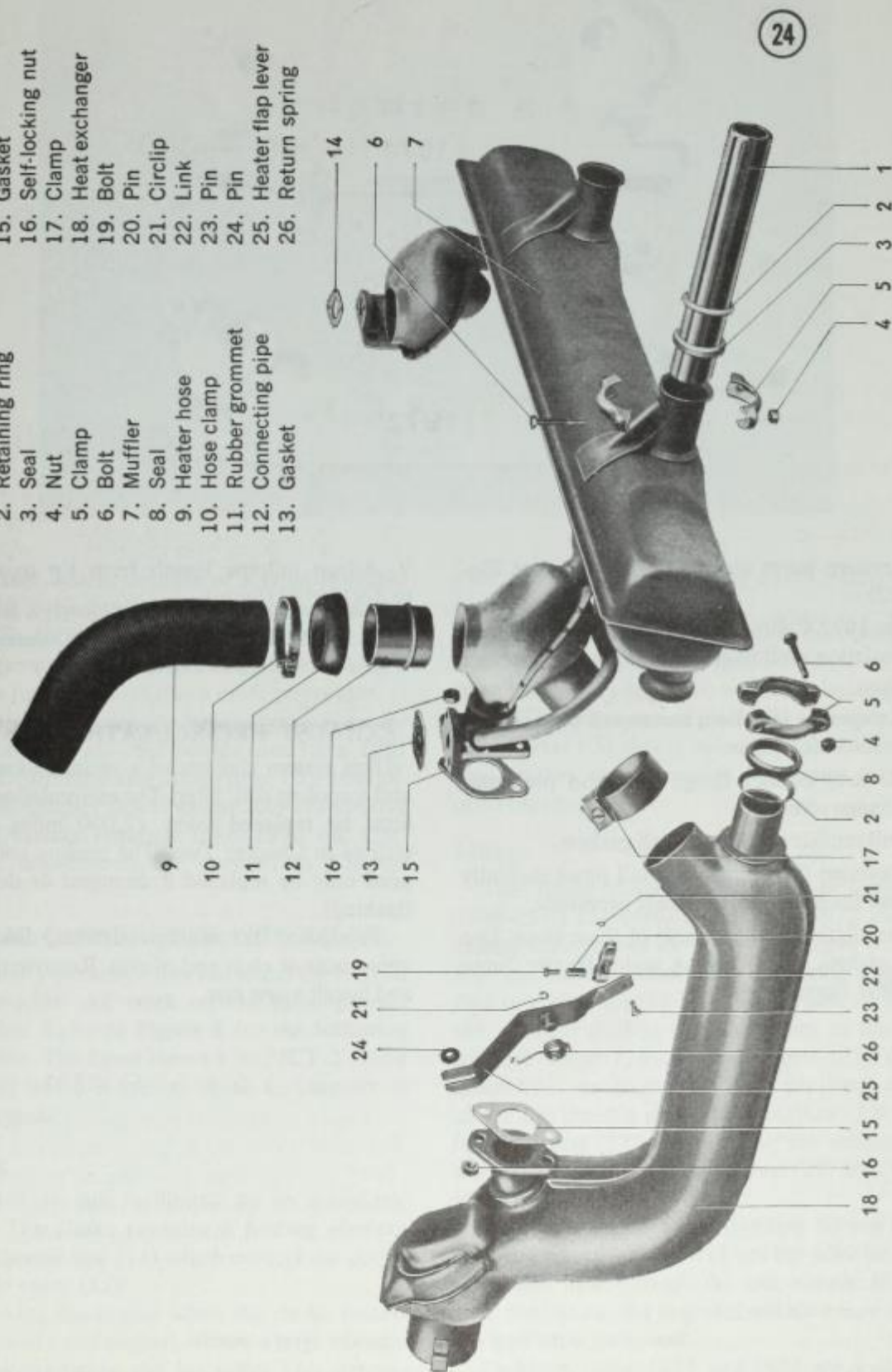
EXHAUST SYSTEM

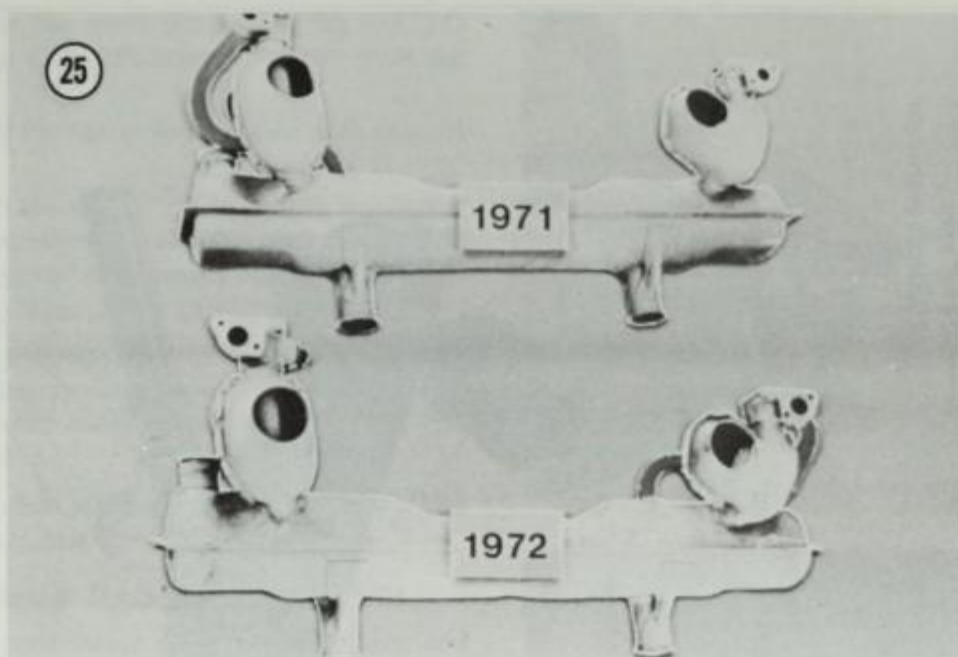
Figure 24 shows the complete exhaust system for 1961-1971. A different muffler is used on 1972 models, since the flow of preheating gas for the intake manifold is reversed. See Figure 25. The 1972 muffler may be installed on earlier models if the 1972 warm air pickup pipe is also used.

Muffler Replacement

1. Remove clamps between muffler and heat exchanger (1963-1972 only). See Figure 21.

1. Tail pipe
2. Retaining ring
3. Seal
4. Nut
5. Clamp
6. Bolt
7. Muffler
8. Seal
9. Heater hose
10. Hose clamp
11. Rubber grommet
12. Connecting pipe
13. Gasket
14. Gasket
15. Gasket
16. Self-locking nut
17. Clamp
18. Heat exchanger
19. Bolt
20. Pin
21. Circlip
22. Link
23. Pin
24. Pin
25. Heater flap lever
26. Return spring





2. Remove warm air channel clamps (see Figure 22).

3. On 1972 California models, remove exhaust recirculation coil/filter as described in the next heading.

4. If engine is installed, loosen tail pipe clamps and remove tail pipes.

5. Remove muffler flange nuts and preheater pipe flange screws.

6. Pull muffler off. Remove all gaskets.

7. Examine the muffler and tail pipes carefully for leaks or damage. Replace if necessary.

8. Installation is the reverse of these steps. Use new gaskets. See Warning under Heater Junction Box Replacement.

9. Adjust tailpipe length from tip to muffler to 8-9/32" (210mm).

NOTE: Tailpipe length affects exhaust flow and engine back pressure.

EXHAUST RECIRCULATION SYSTEM

This system consists of a recirculation valve and a cooling coil/filter. The recirculation valve must be replaced every 12,000 miles as described in Chapter Two. The cooling coil/filter need only be replaced if damaged or defective (leaking).

To replace the cooling coil/filter, disconnect union nuts at each end of coil. Remove the coil and install a new one.

CHAPTER SIX

FUEL SYSTEM

The fuel system consists of a front-mounted fuel tank connected through a line to the fuel pump. An eccentric cam on the distributor drive shaft operates the mechanical fuel pump which delivers fuel to a Solex down draft carburetor.

This chapter contains repair procedures for all carburetors and fuel pumps used from 1961 to 1972. Specifications are on page 105. In addition, this chapter describes the fuel evaporative control system required from 1970 on. Carburetor adjustments are covered in Chapter Two.

BASIC CARBURETOR PRINCIPLES

A variety of carburetors are found on 1961 to 1972 models. All work on the same general principles. Refer to **Figure 1** for the following discussion. The figure shows a 30 PICT-2 (1968 & 1969) which is typical of all carburetors in this chapter.

Starting

Cold starts are facilitated by an automatic choke. The choke contains a heating element and a bimetal coil (14) which control the choke butterfly valve (13).

Cranking the engine when the choke butterfly is closed (cold engine) creates a large vacuum (depression) below the butterfly. This depression draws fuel from the main jet (25) and air

correction jet (10), providing a rich mixture for easy starting.

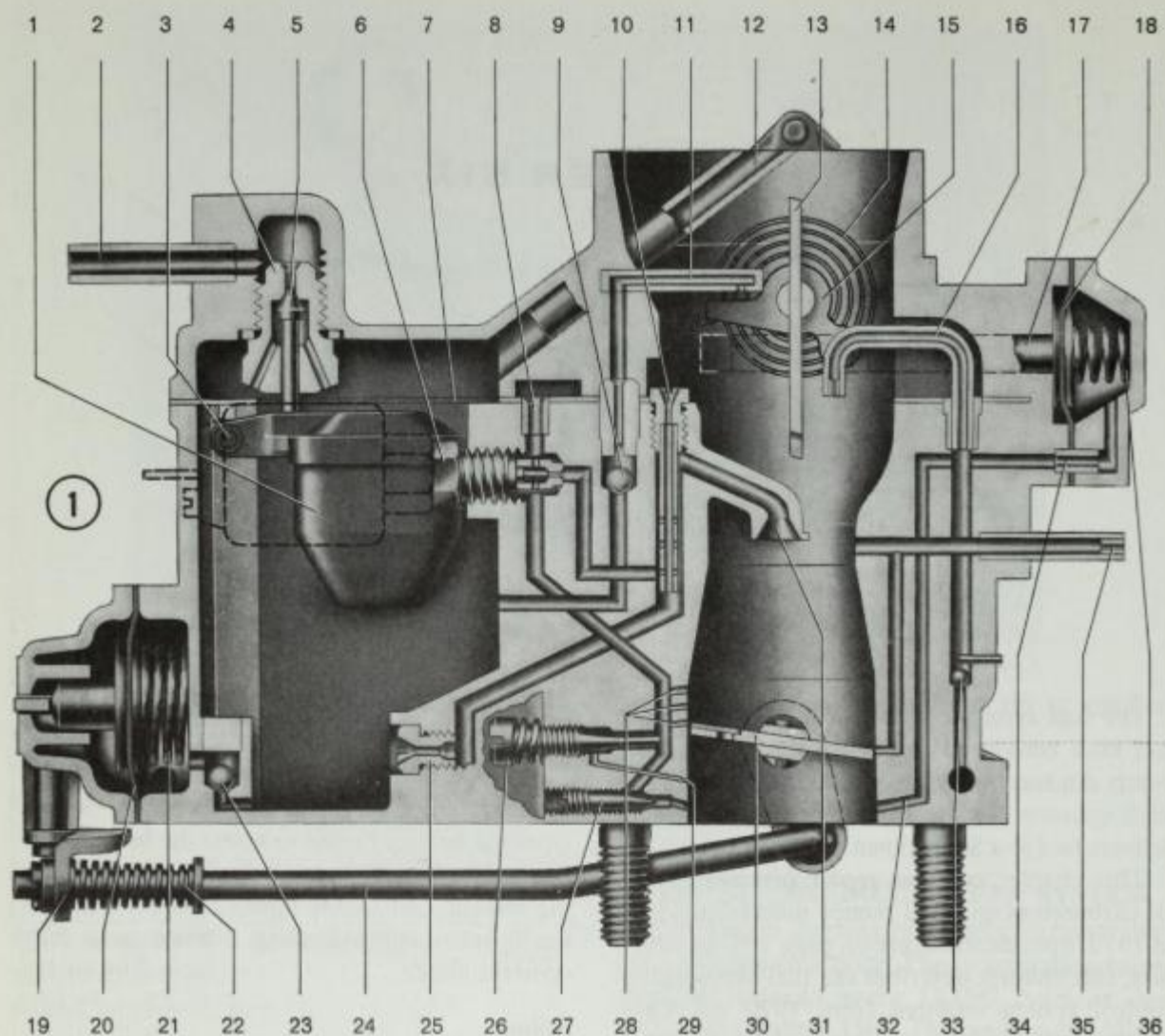
As soon as the ignition switch is turned on, whether the engine is cranked or not, current from the battery begins to warm the heating element. The temperature gradually increases and the bimetal coil slowly opens the choke butterfly; it takes approximately 3 minutes to fully open the choke.

Idling

The idling circuit differs slightly between 1968-1970 carburetors and 1971-1972 carburetors. Carburetors for 1968-1970 have a drilling near the emulsion tube (10) which supplies fuel to a pilot jet (6). Fuel mixes with air from the pilot air drilling (8) and passes to the idle mixture screw (26). By-pass ports (28) draw additional air from the high pressure point above the throttle plate. Idle mixture (26) and fuel metering (27) screws meter the amount of mixture admitted to the idle port (29) for eventual combustion.

When the engine stops (ignition turned off), the pilot jet cut-off valve closes the pilot jet and stops fuel flow through the idle circuit. If this jet is not closed, the engine tends to run-on after the ignition is turned off.

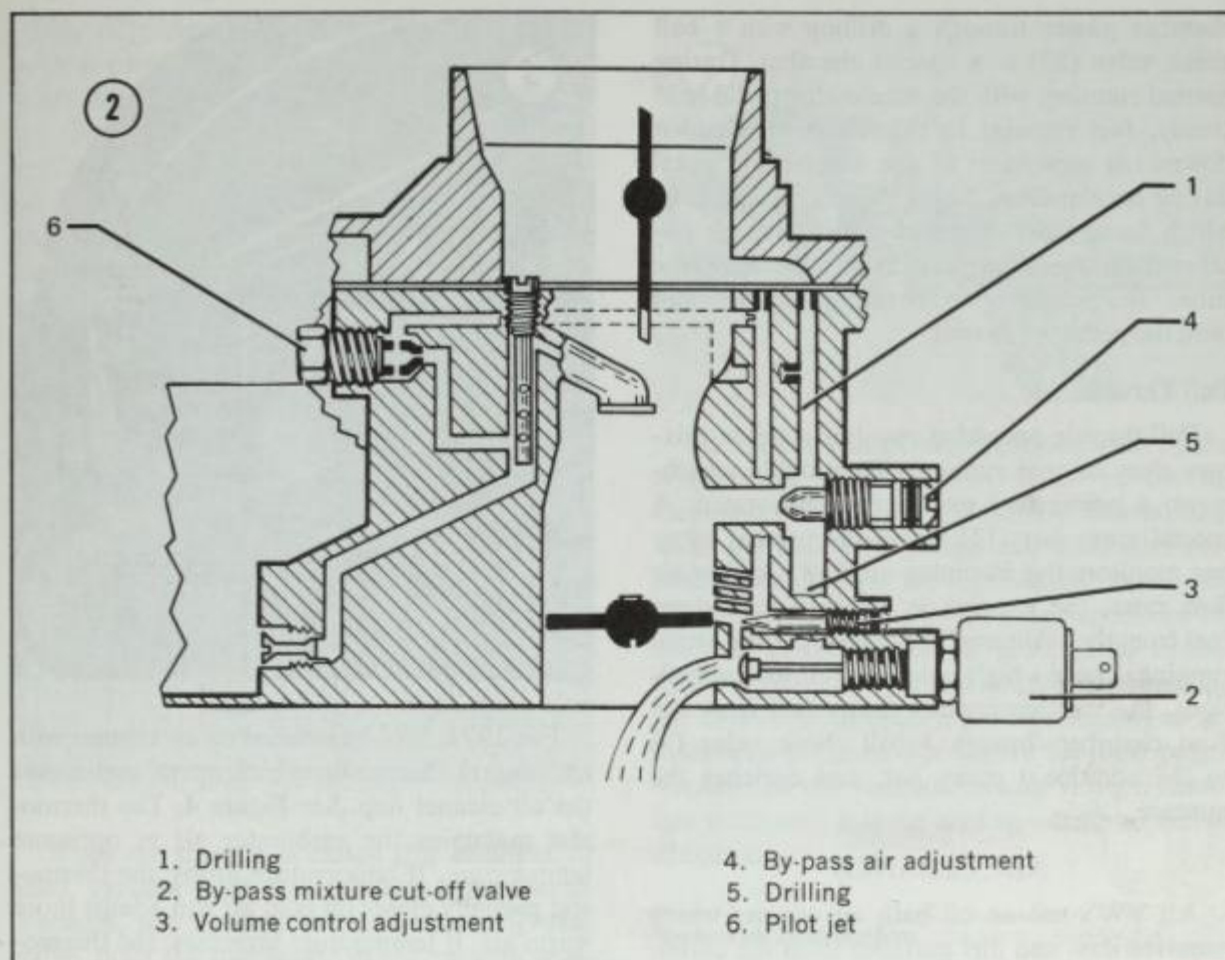
Carburetors for 1971 and 1972 use a different idling circuit as shown in **Figure 2**. The



- | | | |
|--|--|--|
| 1 - Float | 13 - Choke valve | 25 - Main jet |
| 2 - Fuel line | 14 - Bi-metal spring | 26 - Volume control screw |
| 3 - Float lever | 15 - Operating lever | 27 - Fuel metering screw*) |
| 4 - Float needle valve | 16 - Accelerator pump discharge tube | 28 - By-pass port |
| 5 - Float needle | 17 - Diaphragm rod | 29 - Idle port |
| 6 - Pilot jet | 18 - Vacuum diaphragm | 30 - Throttle valve |
| 7 - Gasket | 19 - Pump lever | 31 - Discharge arm |
| 8 - Pilot air drilling | 20 - Pump diaphragm | 32 - Vacuum drilling |
| 9 - Ball check valve in power fuel system | 21 - Spring | 33 - Ball check valve in accelerator pump drilling |
| 10 - Air correction jet with emulsion tube | 22 - Push rod spring | 34 - Jet in vacuum drilling |
| 11 - Power fuel tube | 23 - Ball check valve for accelerator pump | 35 - Vacuum connection |
| 12 - Float bowl vent tube | 24 - Pump connector rod | 36 - Diaphragm spring |

Caution:

*) Do not change the adjustment of this screw.



throttle plate remains completely closed during idle. Fuel from the pilot jet (6) passes to the idle circuit through drillings. Fuel from drilling (1) mixes with air from the venturi and by-pass air screw (4) varies the **amount** of mixture delivered through drilling (5) to the intake manifold. The fuel delivered through drilling (1) depends entirely on venturi pressure, therefore by-pass air screw (4) cannot vary idle mixture **composition**. Idle mixture composition (air-fuel ratio) is factory set with volume control screw (3) and should never require readjustment.

When the engine stops (ignition turned off), the by-pass mixture cut-off valve closes the idle mixture flow rather than closing the pilot jet.

Normal Running

During normal running, i.e., neither idle nor full load conditions, air entering the venturi draws fuel from the spray bar located at a point of maximum depression. Fuel for the spray bar passes from the float chamber to the main jet

(25) and then to the emulsion tube. The air correction jet draws a metered quantity of air from a high pressure area which mixes with the fuel in a 12 or 13 to 1 ratio.

The emulsion tube maintains a constant air-fuel ratio. This tube has a series of holes along its length. At low air flows, the difference in pressure between the inside and outside of the tube is low. Fuel fills the passage around the tube and admits air only through the upper ring of holes. When air flow increases, the pressure difference between the inside and outside of the tube increases and fuel level in the passage drops. The fuel level uncovers additional rings of holes, admitting more air and maintaining the proper air-fuel ratio. The emulsion tube, therefore, acts as a variable air jet.

Acceleration

An accelerator pump, connected to the throttle linkage, instantaneously injects extra fuel through a discharge tube to provide rapid acceleration without a flat spot. Fuel from the float

chamber passes through a drilling with a ball check valve (23) to a special chamber. During normal running, with the accelerator pedal held steady, fuel remains in this chamber. Sudden downward movement of the accelerator pedal during acceleration, flexes the diaphragm (20) which forces fuel in the chamber through another ball check valve (33) to the discharge tube. The acceleration chamber cannot refill until the pedal is released.

Full Throttle

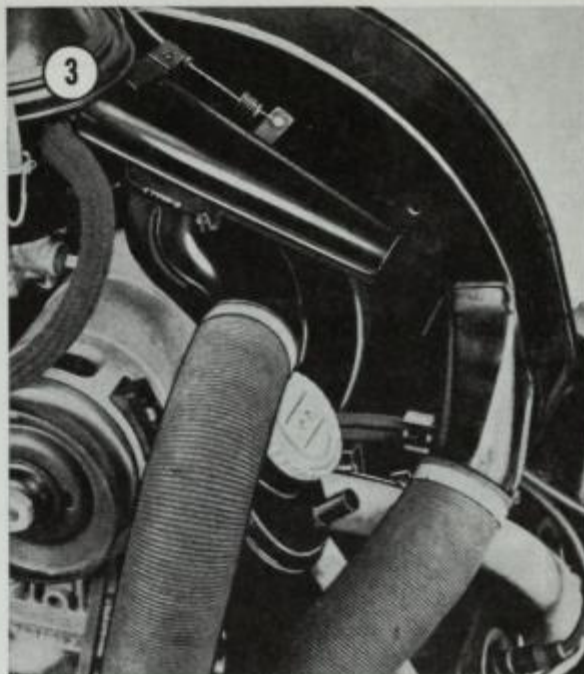
Full throttle operation requires a richer mixture than normal running. To provide enrichment, a power fuel system is incorporated. A special spray bar (11) above the normal spray bar monitors the incoming air flow. At low air flow rates, the vacuum is insufficient to draw fuel from the additional spray bar; this is normal running. During high speed or full load conditions, the vacuum created draws fuel from the float chamber through a ball check valve (9) to the additional spray bar, and enriches the mixture.

AIR CLEANER

All VW's use an oil bath air cleaner which removes dust and dirt particles from the carburetor air. In addition, air cleaners from 1961-1972 have means to control the temperature of the air introduced to the carburetor.

The air temperature control on 1961-1967 models is very simple. Counterweighted flaps on the air intakes close off cold air when the engine is idling, and introduce preheated air from the engine cooling system near the exhaust system. At higher engine speeds, engine vacuum through the carburetor overcomes the weighted flaps, which open and admit cold air to the carburetor. At intermediate speeds, the flap permits a mixture of preheated and cold air.

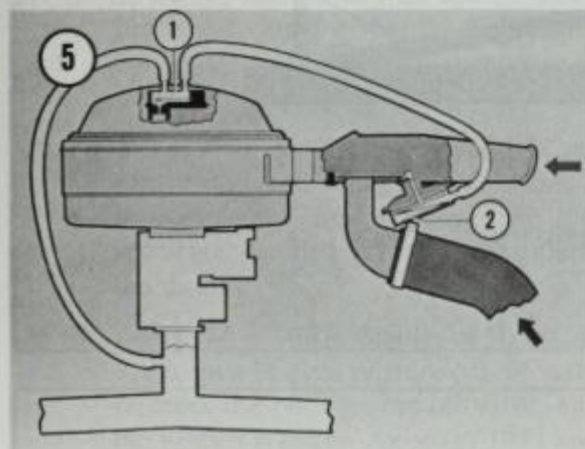
Models from 1968-1970 have a more sophisticated temperature control system. A Bowden cable connected to the right control flap in the fan housing opens or closes the air cleaner flap according to engine temperature. See **Figure 3**. When the engine is cold, only preheated air reaches the carburetor. As the engine warms, more and more cold air is admitted. When the engine is fully warmed, only cold air is admitted.



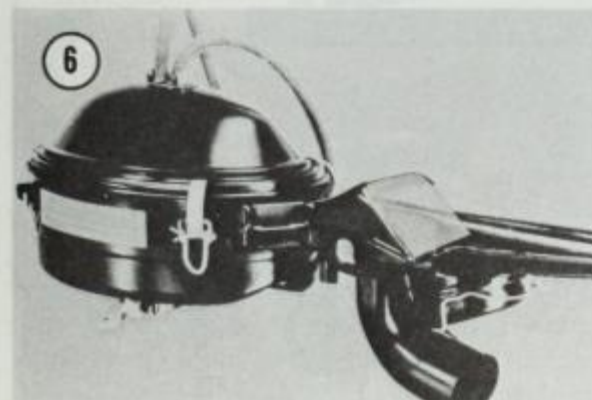
For 1971, VW introduced an air cleaner with an integral thermostat which opens and closes the air cleaner flap. See **Figure 4**. The thermostat maintains the carburetor air at optimum temperature. If temperature drops, the thermostat partially closes off cold air and admits more warm air. If temperature increases, the thermostat admits more cold air.



On 1972 models, preheated air to the carburetor is controlled by air temperature and engine load. A temperature sensing valve is located in the top of the air cleaner (1, **Figure 5**) and an engine vacuum operated valve is located in the air intake (2, **Figure 5**). Vacuum to operate the valve originates in the intake manifold below the carburetor and passes through the temperature sensing valve to the vacuum sensing valve.



When the throttle is closed (for example, at idle), vacuum from the manifold is maximum. Vacuum, felt through the temperature sensing valve, pulls the diaphragm in the vacuum sensing valve which pushes the air flap up as shown in **Figure 6**. This flap closes off the supply of cold air and only preheated air reaches the carburetor.



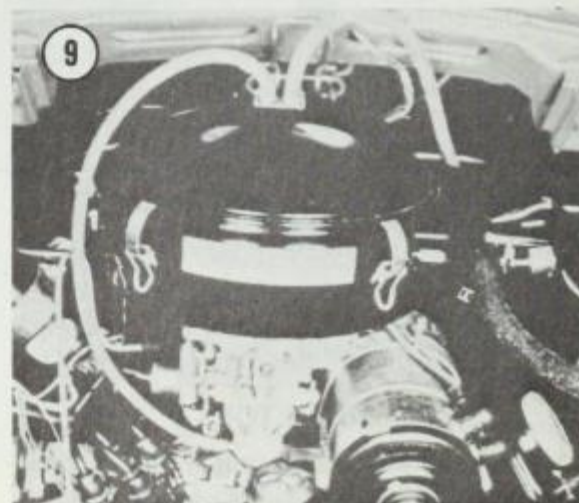
If the throttle is partially opened and the engine accelerated, vacuum drops and the flap permits a mixture of cold and preheated air. During full throttle operation, the flap closes off all preheated air and only cold air is admitted to the carburetor. See **Figure 7**.

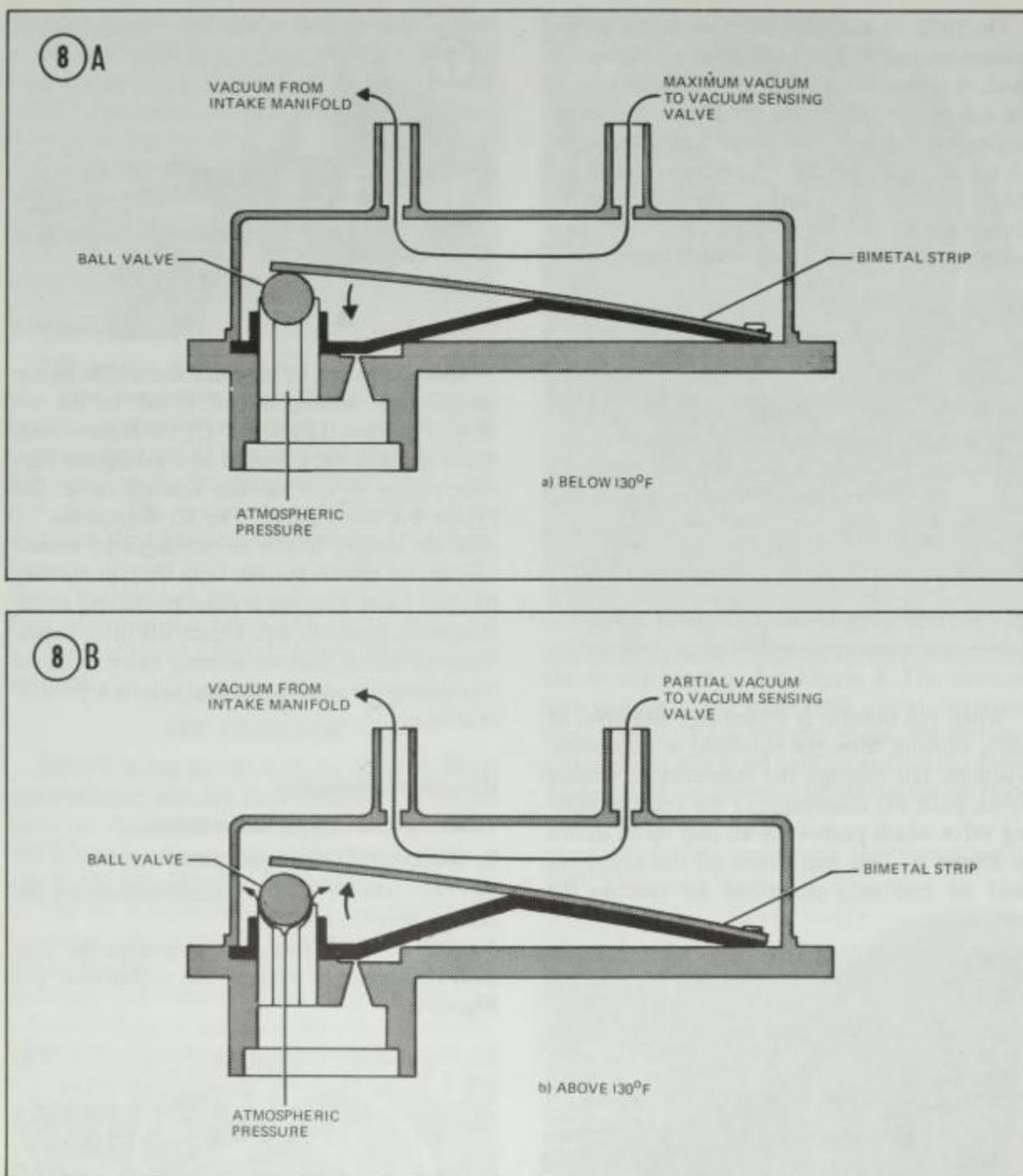


This action can be modified somewhat by the temperature sensing valve. If air in the air cleaner is below 130°F (55°C), the bimetal strip holds the ball valve closed and maximum vacuum passes to the vacuum sensing valve. See **Figure 8A** (next page). The air flap closes off cold air intake. If the air attempts to exceed 130°F (55°C), the bimetal strip rises, permitting the ball valve to open a passage leading to atmospheric pressure. See **Figure 8B** (next page). Vacuum to the vacuum sensing valve is therefore decreased and the air flap admits a portion of cold air.

Removal/Installation

1. Remove the air preheater hose(s).
2. Remove the oil breather tube.
- 3a. On 1968-1970 air cleaners, disconnect the automatic preheater cable.
- 3b. On 1972 air cleaners, disconnect the vacuum line near the base of the carburetor. See **Figure 9**.





4. Loosen the clamp at the bottom of the air cleaner and pull the air cleaner off. Keep it level; it contains oil.

5. Installation is the reverse of these steps. See Chapter Two for cleaning.

CARBURETORS

Six different Solex downdraft carburetors are used from 1961 to 1972. They are so similar,

however, that the same procedures apply with only minor differences. Below is a summary of the differences.

28 PICT (1961-1963): First VW carburetor with automatic choke. Vacuum piston opens the choke butterfly slightly when the engine starts. Has power fuel system. See 30 PICT-2.

28 PICT-1 (1964 & 1965): Same as 28 PICT except vacuum diaphragm replaces vacuum piston. No power fuel system. See 30 PICT-2.

30 PICT-1 (1966 & 1967): Similar to 28 PICT-1, except larger venturi. No power fuel system. See 30 PICT-2.

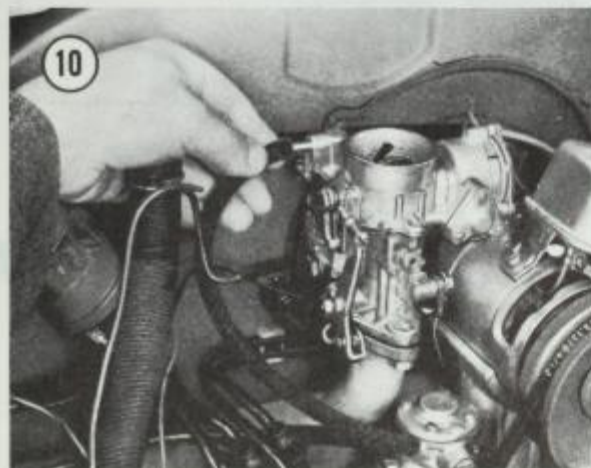
30 PICT-2 (1968 & 1969): Similar to 30 PICT-1, except has power fuel system which draws fuel directly from the float chamber under full load, high speed conditions.

30 PICT-3 (1970): Similar to 30 PICT-2, except redesigned idling permits throttle to completely close at idle while idle speed is controlled by air by-pass around the throttle.

34 PICT-3 (1971 & 1972): Similar to 30 PICT-3, except a by-pass mixture cut-off valve replaces the pilot jet cut-off valve, and the venturi is larger. Although 1971 and 1972 carburetors are both 34 PICT-3 types, differing choke parts prevents interchangeability.

Removal/Installation

1. Remove the air cleaner as described previously.
2. Pull the fuel line and vacuum line off the carburetor. See **Figure 10**.



3. Disconnect the electrical wires to the automatic choke and pilot jet cut-off valve (1961-1970) or by-pass mixture cut-off valve (1971 and 1972).

4. Disconnect the accelerator cable from the throttle linkage. Remove both carburetor mounting nuts (see **Figure 11**) and pull the carburetor off.

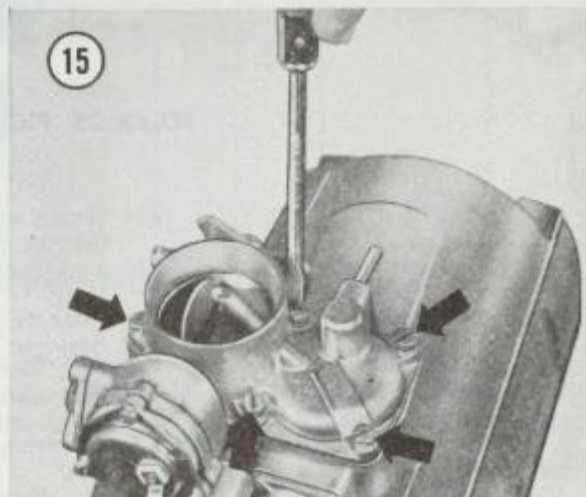


5. Installation is the reverse of these steps. Use a new gasket between the carburetor and intake manifold, tighten the nuts evenly and adjust the carburetor as described previously.

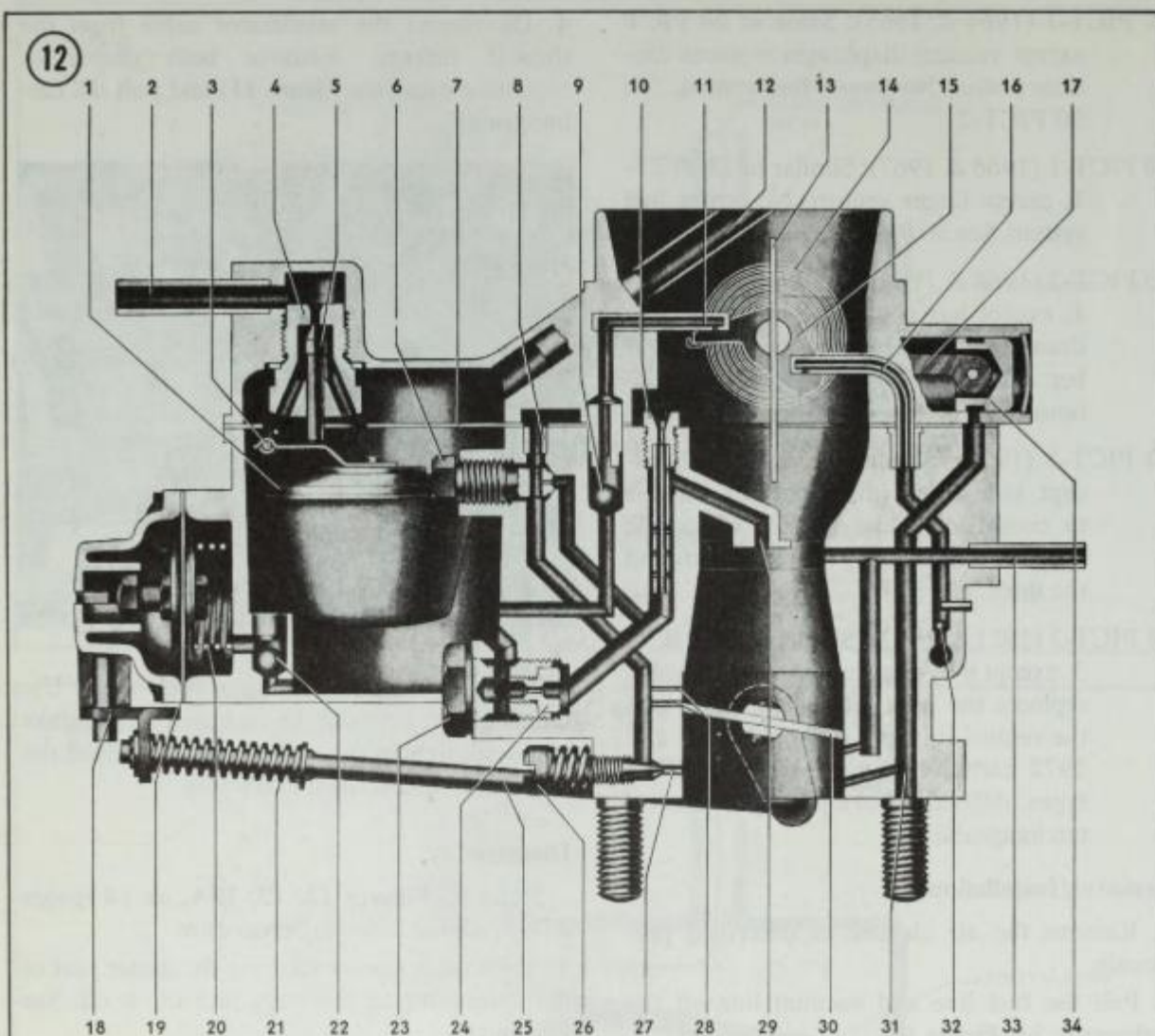
Disassembly

Refer to **Figures 12, 13, 13A, or 14** (pages 92-95) for the following procedure.

1. Remove 5 screws securing the upper part of the carburetor to the body and lift it off. See **Figure 15**.



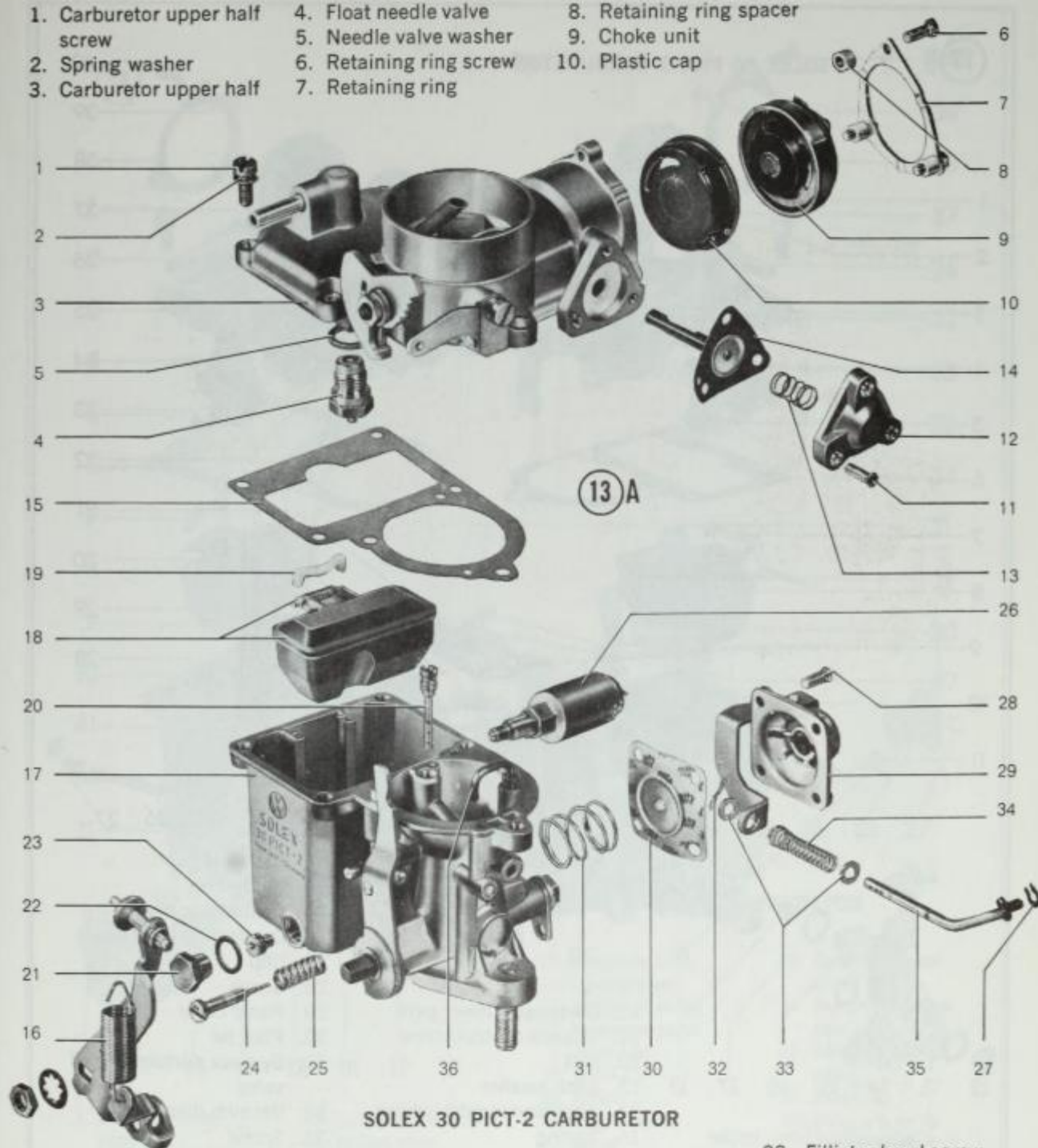
2. Pull out the float retainer and the float.
3. Unscrew the float needle valve from the upper part of the carburetor.



SOLEX 28 PICT CARBURETOR

- | | | |
|--|---|---|
| 1. Float | 14. Bi-metal spring | 26. Volume control screw |
| 2. Fuel line | 15. Operating lever | 27. Idle port |
| 3. Float lever | 16. Accelerator pump discharge tube | 28. Bypass port |
| 4. Float needle valve | 17. Piston rod | 29. Discharge arm |
| 5. Float needle | 18. Pump lever | 30. Throttle valve |
| 6. Pilot jet | 19. Pump diaphragm | 31. Vacuum drilling |
| 7. Gasket | 20. Diaphragm spring | 32. Ball check valve in accelerator pump drilling |
| 8. Pilot air drilling | 21. Spring | 33. Vacuum connection |
| 9. Ball check valve | 22. Ball check valve for accelerator pump | 34. Vacuum piston |
| 10. Air correction jet and emulsion tube | 23. Main jet carrier | |
| 11. Power fuel tube | 24. Main jet | |
| 12. Float bowl vent tube | 25. Pump connector rod | |
| 13. Choke valve | | |

- | | | |
|--------------------------------|-------------------------|--------------------------|
| 1. Carburetor upper half screw | 4. Float needle valve | 8. Retaining ring spacer |
| 2. Spring washer | 5. Needle valve washer | 9. Choke unit |
| 3. Carburetor upper half | 6. Retaining ring screw | 10. Plastic cap |
| | 7. Retaining ring | |

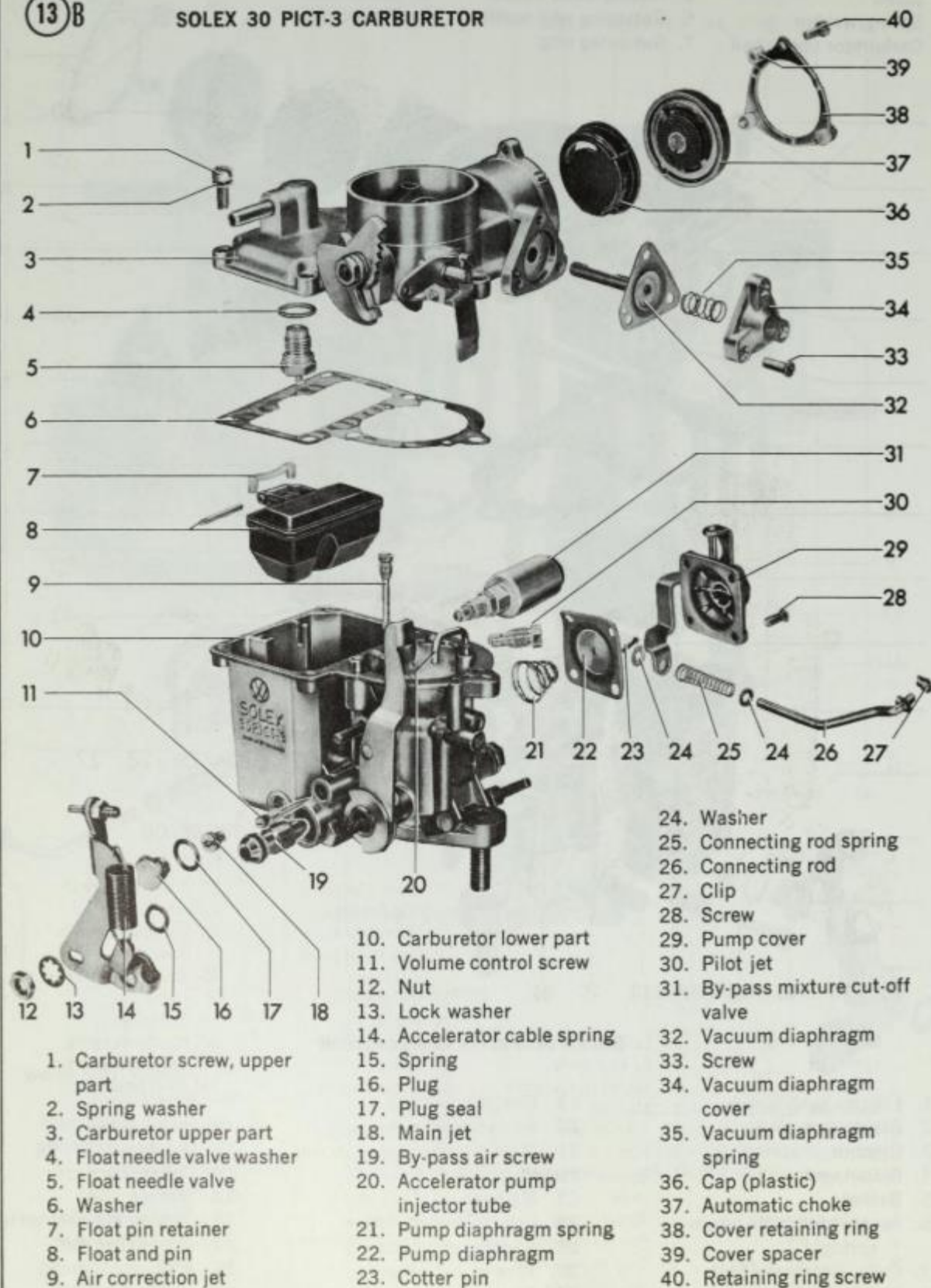


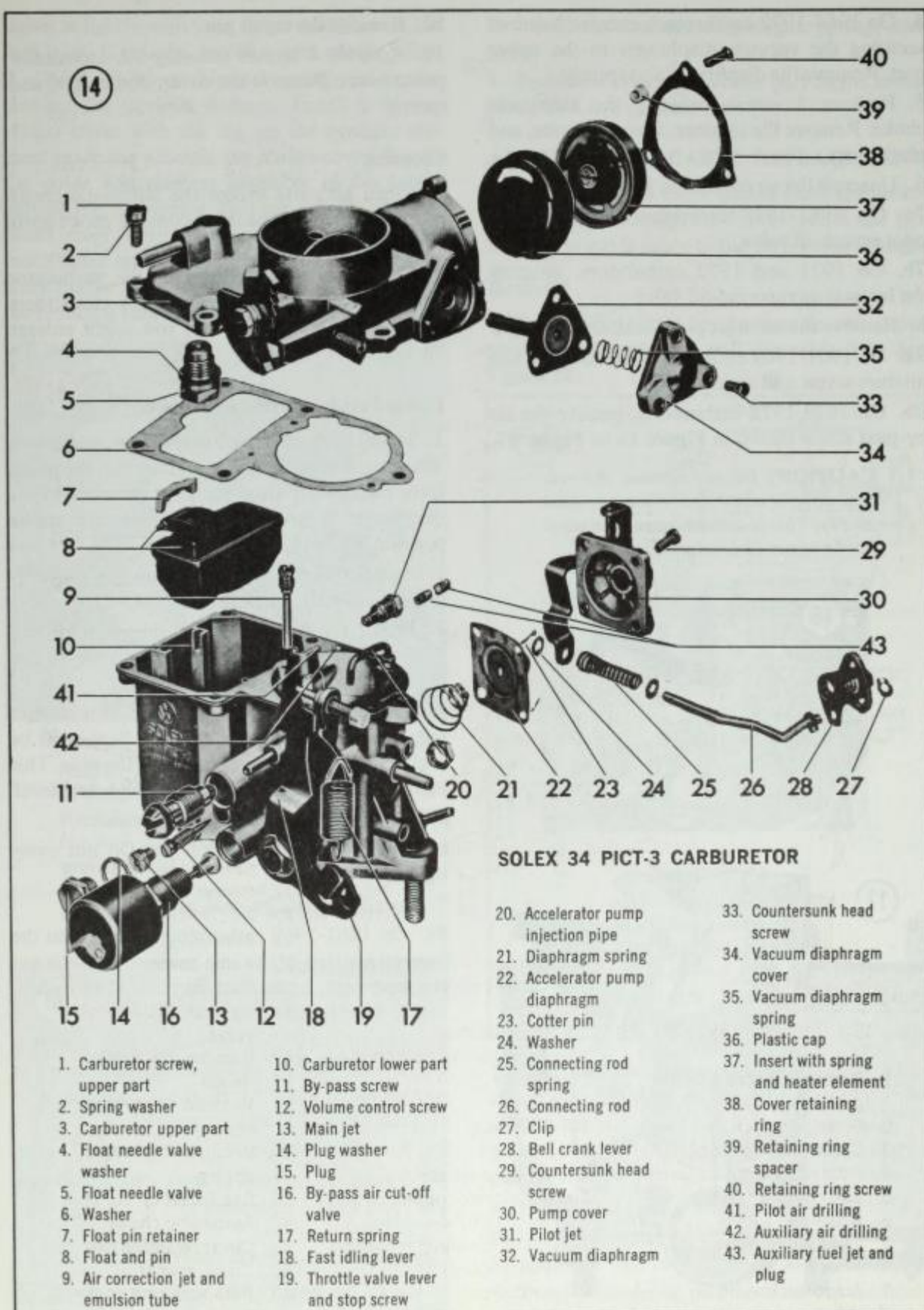
SOLEX 30 PICT-2 CARBURETOR

- | | | |
|-------------------------------------|-----------------------------|------------------------------------|
| 11. Fillister head screw | 19. Float pin bracket | 28. Fillister head screw |
| 12. Diaphragm cover | 20. Air correction jet | 29. Pump cover |
| 13. Diaphragm spring | 21. Main jet plug | 30. Pump diaphragm |
| 14. Diaphragm | 22. Plug seal | 31. Diaphragm spring |
| 15. Gasket | 23. Main jet | 32. Cotter pin |
| 16. Accelerator cable return spring | 24. Volume control screw | 33. Washer |
| 17. Carburetor lower half | 25. Spring | 34. Connecting rod spring |
| 18. Float and pin | 26. Pilot jet cut-off valve | 35. Connecting rod |
| | 27. Circlip | 36. Accelerator pump injector tube |

13 B

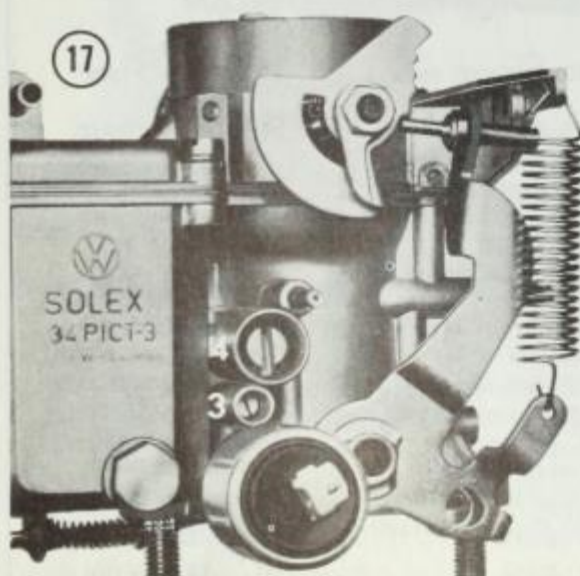
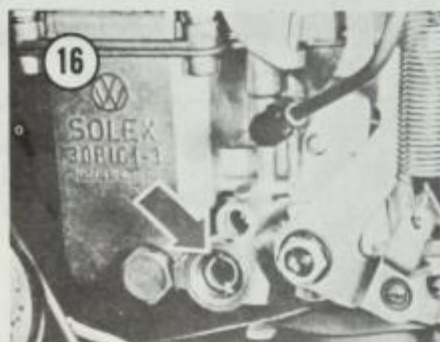
SOLEX 30 PICT-3 CARBURETOR





4. On 1964-1972 carburetors, remove 3 screws securing the vacuum diaphragm to the upper part. Remove the diaphragm and spring.
5. Remove 3 screws securing the automatic choke. Remove the retainer, spacers, choke, and plastic cap.
6. Unscrew the air correction jet.
- 7a. On 1961-1970 carburetors, unscrew the pilot jet cut-off valve.
- 7b. On 1971 and 1972 carburetors, unscrew the by-pass mixture cut-off valve.
8. Remove the main jet plug, seal, and main jet.
- 9a. On 1961-1969 carburetors, remove the idle mixture screw and spring.
- 9b. On 1970-1972 carburetors, remove the air by-pass screw shown in **Figure 16** or **Figure 17**.

CAUTION: Do not remove the volume control screw near the air by-pass screws. This is factory preset and must not be removed or adjusted.



3. Volume control screw

4. By-pass screw

10. Remove the cotter pin.
11. Remove 4 screws securing the accelerator pump cover. Remove the cover, diaphragm, and spring.

Cleaning

1. Clean all parts except the automatic choke parts in solvent. Wipe the automatic choke parts with a clean cloth.
2. Clean jets and drillings in the carburetor body with compressed air. Do not clean them with pins or pieces of wire; you might enlarge the holes.

Lower Part Inspection & Assembly

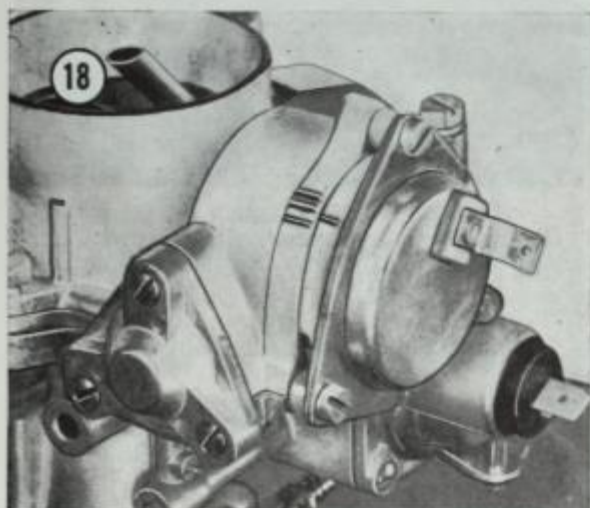
1. Install the spring, new diaphragm, and cover. When tightening the cover screws, pull the pump lever back, away from the float chamber so the diaphragm is secured in the pressure stroke position.
2. Install the connecting rod on the butterfly valve lever with a snap ring, if removed.
3. Install the washers and spring in the order shown in the figure. Insert cotter pin in the innermost hole in the connecting rod.
4. Immerse the float in hot water. If it is leaking, bubbles will appear, and the float must be replaced. Do not attempt to solder the hole. This increases float weight and causes high fuel level.
5. Install the float with the float retainer.
6. Install the air correction jet. Do not over-tighten.
7. Install the main jet, seal, and plug.
- 8a. On 1961-1969 carburetors, ensure that the tapered portion of the idle mixture screw is not grooved, bent, or marked. Replace if necessary. Install the idle mixture screw.
- 8b. On 1970-1972 carburetors, make sure that the tapered portion of the air by-pass screw is not grooved, bent or marked. Replace it if necessary. Install the air by-pass screw.
- 9a. Install the 1961-1970 pilot jet cut-off valve.
- 9b. Install the by-pass mixture cut-off valve on 1971 and 1972 carburetors.

Upper Part Inspection & Assembly

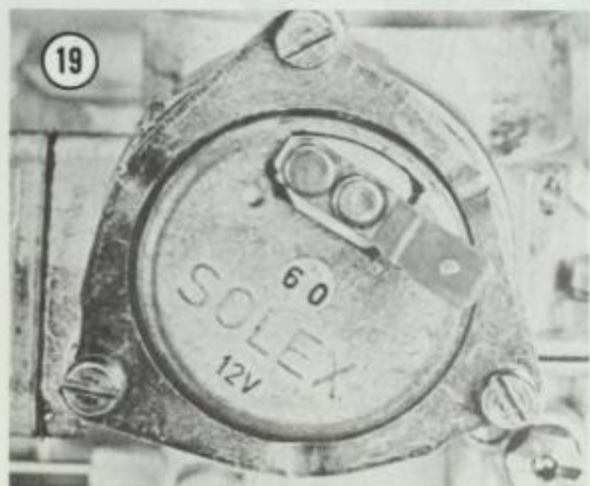
1. Check the float needle valve for leakage. To do this, install it in the upper body, hold the

valve in lightly with your finger and blow in the fuel inlet. If it leaks, install a new needle valve.

2. Check the choke bimetal spring and heater element for obvious damage. Install it in the plastic cover with the lug on the ceramic element (a) in the notch in the plastic cover. Install the cover and element assembly in the upper part of the carburetor with the spacers and retainer ring. Turn the choke assembly so the index mark on the choke is on the center index mark on the carburetor. See **Figure 18**. Tighten the retaining ring screws.



NOTE: Due to improved preheating in 1972 models, the heater elements are different from those in earlier carburetors. Heater elements are **NOT** interchangeable between 1972 carburetors and earlier versions. Elements for 1972 are marked "60" on the cover. See **FIGURE 19**.



3. Install the vacuum diaphragm, spring, and cover.

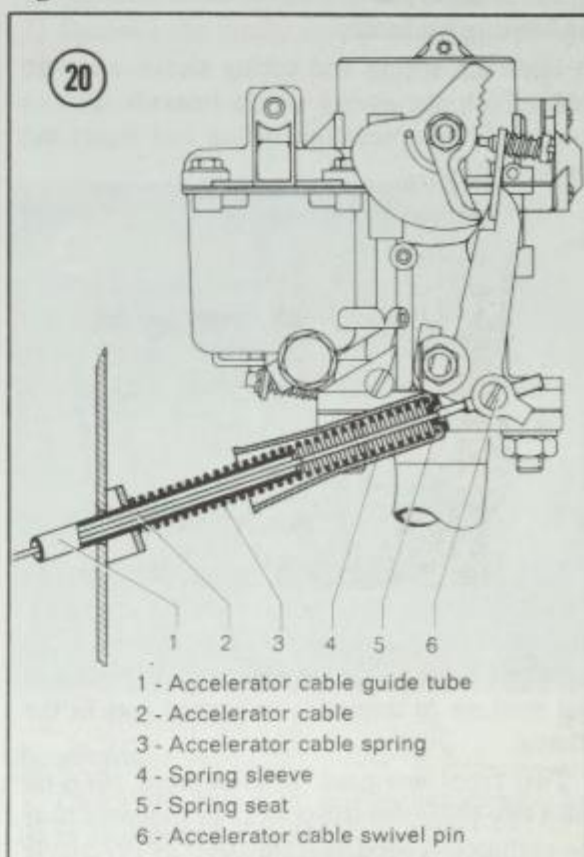
4. Install the upper carburetor part on the lower part with a new gasket.

ACCELERATOR CABLE REPLACEMENT

The accelerator cable passes from the accelerator pedal, through the frame tunnel and fan housing in guide tubes to the carburetor linkage.

Removal

1. Loosen the screw on the throttle swivel pin securing the cable and pull the cable free. See **Figure 20**.



2. Pull the spring sleeve towards the fan housing to compress the return spring. Remove the small retainer.

3. Slide the spring sleeve and spring off the cable.

4. Disconnect the rod from the accelerator pedal and disconnect the cable from the rod.

5. Raise the rear of the car on jack stands.

6. From underneath, pull the cable out the front of the fan housing.

7. Remove the plastic hose from the rear cable end, and remove the rubber boot from the rear of the guide tubes.
8. Pull the cable out the front.

Installation

1. Grease the accelerator cable with universal grease.
2. Install the cable through the frame tunnel. The accelerator cable must lay straight between the guide tubes with no kinks.
3. Install the rubber boot and plastic hose on the guide tubes.
4. From underneath, feed the cable through the fan housing guide tube.
5. Slide the spring and spring sleeve over the cable. Push the spring sleeve towards the fan housing to compress the spring and insert the spring retainer.
6. Insert the cable end into the throttle swivel pin.
7. Have an assistant depress the accelerator fully. Open the carburetor throttle valve until there is about 0.04" clearance between the throttle lever and carburetor stop. Tighten the screw on the swivel pin.

THROTTLE POSITIONER

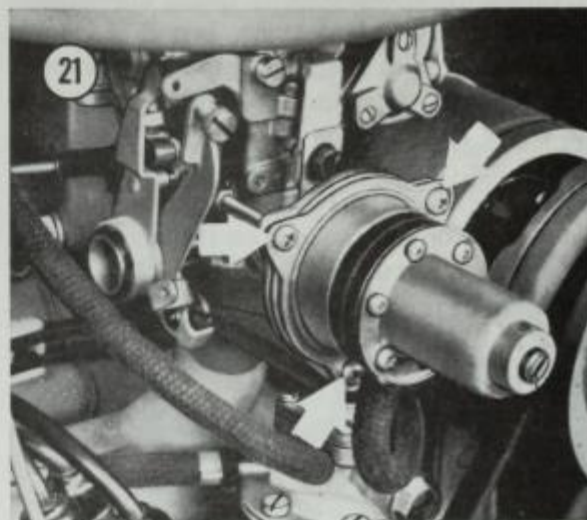
The throttle positioner opens the throttle slightly when the rear wheels drive the engine, e.g., when coasting down a hill or decelerating. A partially open throttle ensures adequate air-fuel mixture to minimize unburned fuel in the exhaust.

Two types are used. Models from 1966-69 use a one-piece throttle positioner mounted near the carburetor. Models from 1970 to 1972 have a two-piece positioner. The actuator portion is mounted near the carburetor; the control portion is mounted on the left side of the engine compartment. Both types serve the same purpose and operate in a similar manner. Neither type can be repaired; replace as a unit if defective.

Removal/Installation

1. Disconnect the vacuum line(s).
2. Remove 3 screws and retaining ring over the

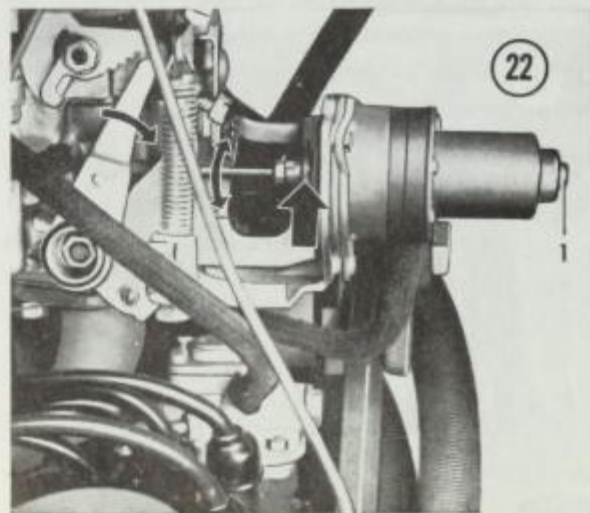
throttle positioner. See **Figure 21**. Remove the positioner.



3. On two-piece units, remove the screws securing the control portion to the engine compartment.
4. Disconnect the positioner from the throttle linkage.
5. Installation is the reverse of these steps. Check the adjustment as described below.

Adjustment (one-piece unit)

1. Connect a tachometer to the engine.
2. Loosen the set screw on the end of the throttle positioner and turn the adjusting screw (1, **Figure 22**) clockwise until the stop washer on the pull rod (arrow, **Figure 22**) contacts the throttle positioner housing. Idle speed should be 1700-1800 rpm.



3. If the engine speed is not 1700-1800 rpm, loosen the locknuts at each end of the pull rod. Rotate the pull rod to lengthen or shorten it to set the engine speed. Tighten the locknuts.

4. Readjust the throttle positioner adjusting screw (1, Figure 22) so the engine speed is 850 rpm.

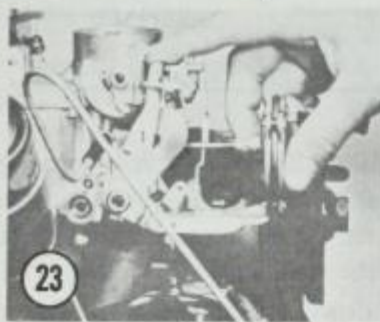
5. Increase engine speed to 3000 rpm with the accelerator pedal, then release it quickly. Engine speed must drop from 3000 rpm to 1000 rpm within 3-4 seconds. If shortening the time is required, turn the adjusting screw (1, Figure 22) clockwise and recheck. If a longer time is required, turn the screw counterclockwise and recheck.

6. Tighten the set screw for the adjusting screw, and recheck the rpm drop time.

Adjustment (two-piece unit)

1. Connect a tachometer to the engine. Check that engine idle speed is 850 rpm. Adjust if necessary.

2. Pull the lever connected to the throttle positioner pull back until it contacts the stop screw on the mounting bracket. See **Figure 23**. Engine speed should be 1700-1800 rpm.



3. If the engine speed is not 1700-1800 rpm, readjust the stop screw. See **Figure 24**.



4. Loosen the set screw on the end of the control portion of the throttle positioner.

5. Increase engine speed to 3000 rpm with the accelerator pedal, then release it quickly. Engine speed must drop from 3000 to 1000 rpm within 3-4 seconds. If a shorter time is required, turn the screw counterclockwise.

6. Tighten the set screw for the adjusting screw and recheck the rpm drop time.

INTAKE MANIFOLD

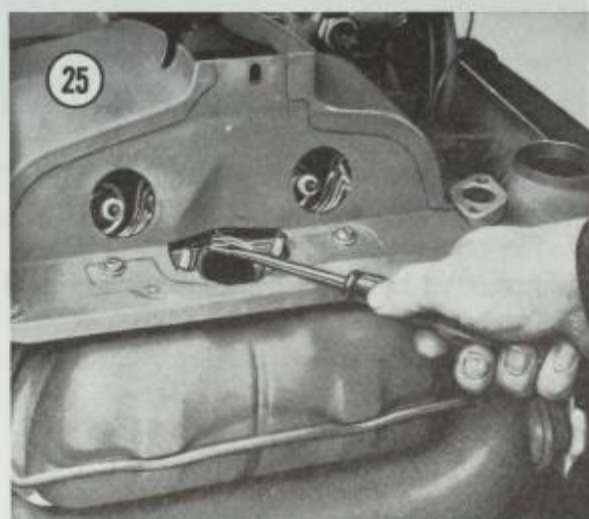
Removal

1. Remove the fan housing and rear cover plate as described in Chapter Five.

2. Remove nuts and bolts securing the manifold to the cylinder heads and exhaust flanges.

3. Remove the intake manifold with preheater pipe.

4. Remove the cylinder head sealing rings. See **Figure 25**.



Inspection

1. Check the manifold and preheater pipe for leaks, and damaged flanges.

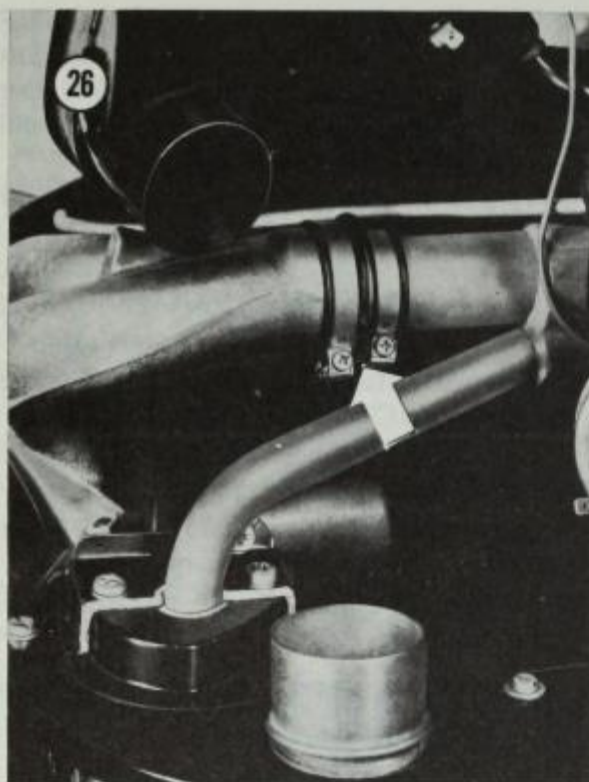
2. Check that the preheater pipe is not blocked. This can be a source of poor acceleration and eventual engine overheating.

3. Check the rubber sleeves on the 1971 and 1972 manifolds for cracks and other signs of deterioration. See **Figure 26**.

Installation

1. Install new gaskets in the cylinder head intake ports.

2. Install new gaskets in the preheater pipe



flanges. The smallest diameter gasket goes in the left hand flange.

3. Place the intake manifold in position.
4. Install all nuts and bolts for the manifold and preheater pipe.
5. Install the fan housing and rear cover plate (see Chapter Five).

FUEL PUMP

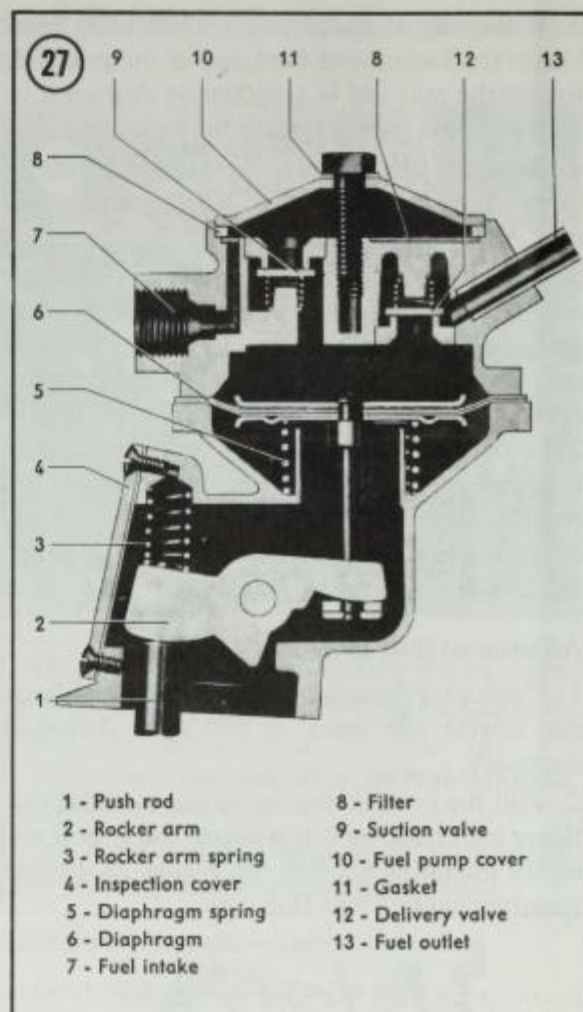
Removal

1. Disconnect the fuel lines from the fuel pump. On 1961-65 fuel pumps, the fuel inlet line must be unscrewed. The 1961-65 fuel outlet and both lines on 1966-72 fuel pumps simply pull off.
2. Remove the mounting nuts and lift the pump off.
3. Remove the pushrod, intermediate flange, and gaskets.

Disassembly

Refer to **Figures 27 or 28** for the following procedure.

- 1a. On 1961-1965 fuel pumps, remove the top cover bolt and lift off the cover and filter.
- 1b. On 1966-1972 fuel pumps, remove the plug

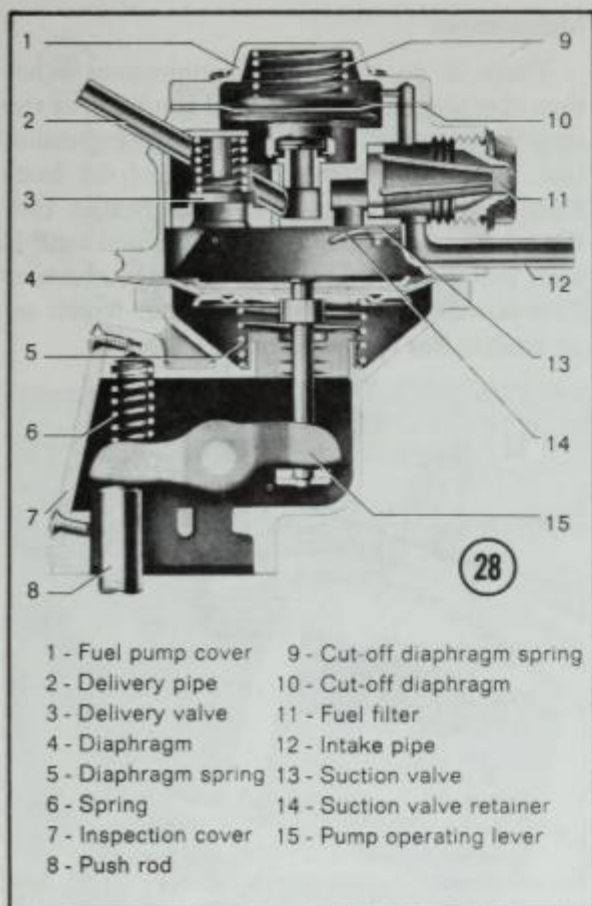


and fuel filter. Remove 4 screws securing the top cover. Lift out the cut-off spring and diaphragm.

2. Remove 6 screws securing the top part of the pump to the main body.
3. Push down on the pump diaphragm to release it from the pump operating lever. Lift the diaphragm and spring out.
4. Carefully drive out the pin holding the operating lever.
5. Remove operating lever and spring.

Inspection

1. Examine the diaphragms for cracks or hardening.
2. Blow gently on the delivery pipe to check the delivery valve. Suck gently on the intake pipe to check the suction valve. If either valve leaks, the entire top portion of the pump must be replaced. In this case, consider installing a rebuilt



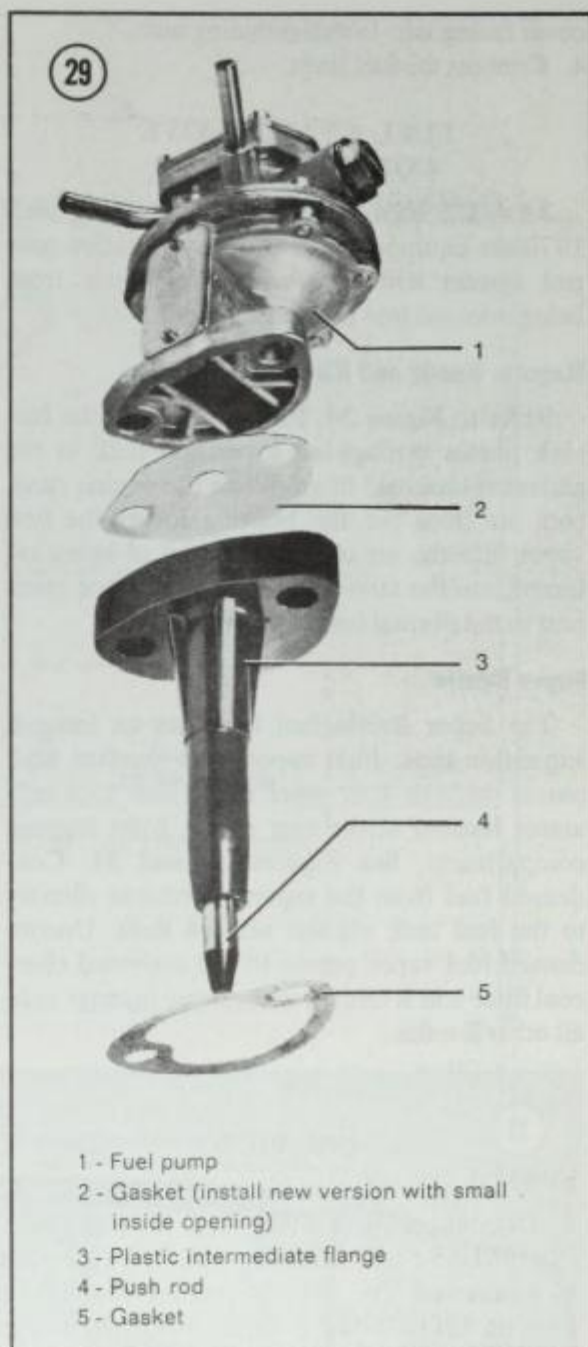
pump; it may be less expensive than salvaging the original.

Assembly

Assembly is the reverse of the disassembly procedure. Use new parts provided in a standard rebuild kit.

Adjustment

1. Install intermediate flange with 2 new gaskets underneath and one on top (see **Figure 29**).
2. Insert the pushrod with rounded end down.
3. Remove the center wire from the ignition coil so the engine won't accidentally start. Turn the engine over by hand until the pushrod is as high as possible.
4. Measure the tip of the pushrod above the surface of the top gasket. This should be about 0.5" (13mm).
5. Turn the engine until the pushrod is at the bottom of its stroke.
6. Measure pushrod height as in step 4. This



should be about 0.3" (8mm). The difference, which is the stroke, should be about 0.16" (4mm). If not, add or remove a gasket under the intermediate flange.

Installation

1. Install and adjust the intermediate flange and pushrod as described above.
2. Pack the opening in the bottom of the fuel pump with universal grease.
3. Install the fuel pump with the inspection

cover facing left. Install retaining nuts.

4. Connect the fuel lines.

FUEL EVAPORATIVE CONTROL SYSTEM

All VW's sold in California beginning with 1970 are equipped with a fuel evaporative control system which prevents fuel vapor from being released into the atmosphere.

Regular Beetle and Karmann Ghia

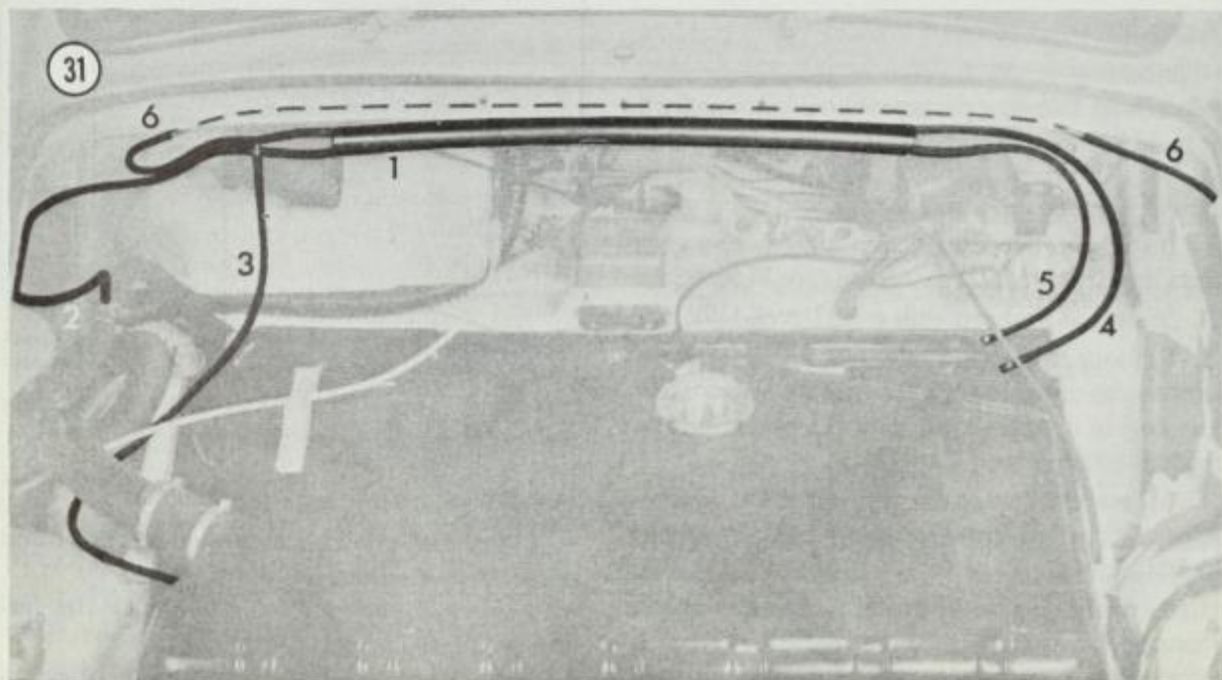
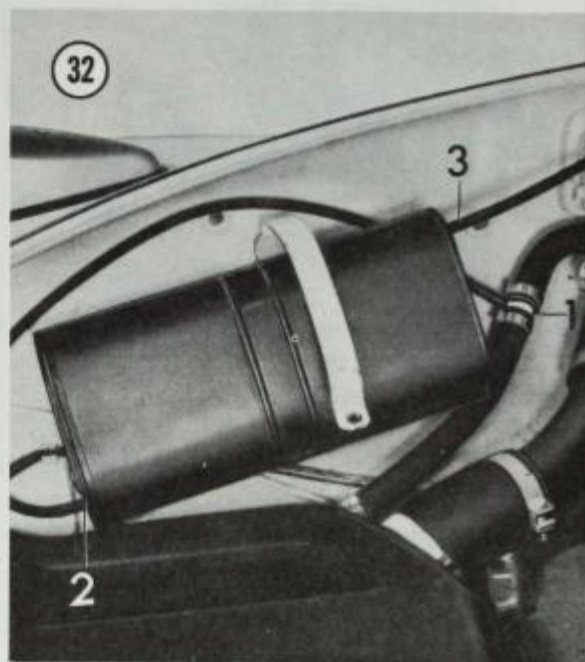
Refer to **Figure 30**. Fuel vapor from the fuel tank passes through an expansion tank to the activated charcoal filter. When the engine runs, cool air from the fan housing forces the fuel vapor into the air cleaner. Instead of being released into the atmosphere, the fuel vapor takes part in the normal combustion process.

Super Beetle

The Super Beetle fuel tank has an integral expansion tank. Fuel vapor from the fuel tank passes through 1 or more of 4 tubes to a separator located at the rear of the front luggage compartment. See **Figures 30 and 31**. Condensed fuel from the separator returns directly to the fuel tank via the same 4 lines. Uncondensed fuel vapor passes to the activated charcoal filter and is treated in the same manner as in all other Beetles.

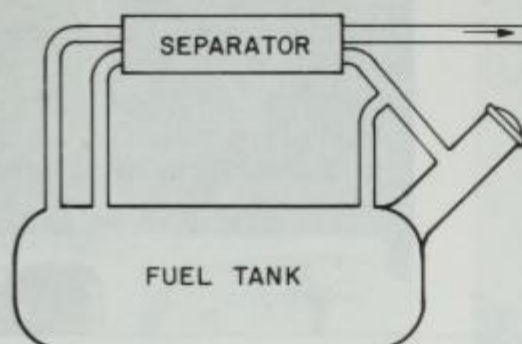
Maintenance

There is no preventive maintenance other than checking the tightness and condition of the lines linking parts of the system. The expansion tank is located on the right side of the front luggage compartment on regular Beetles (see **Figure 32**); the Super Beetle expansion tank is built into the fuel tank. The activated charcoal filter is located under the right rear fender on all models. See **Figure 33** (page 104).

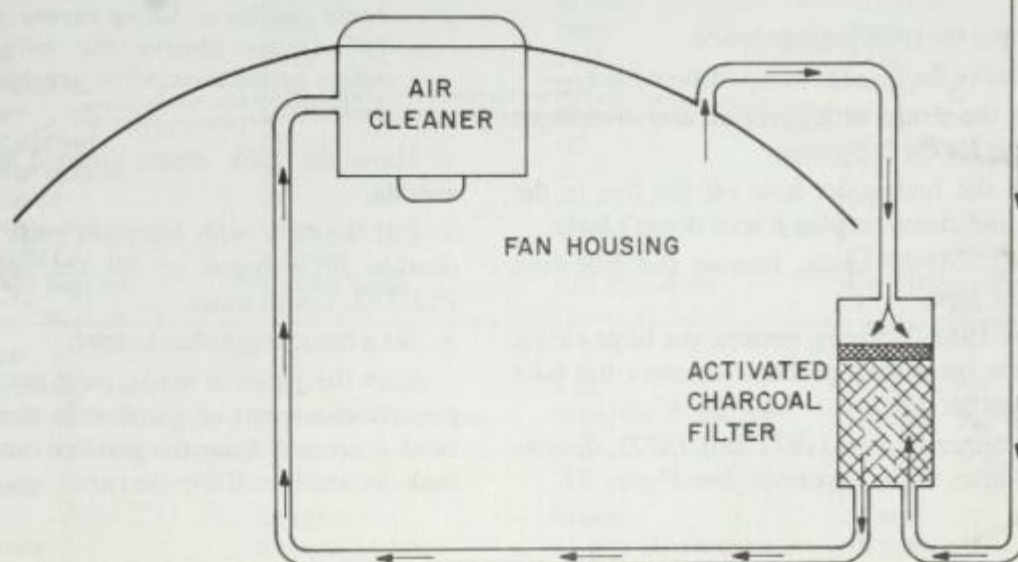
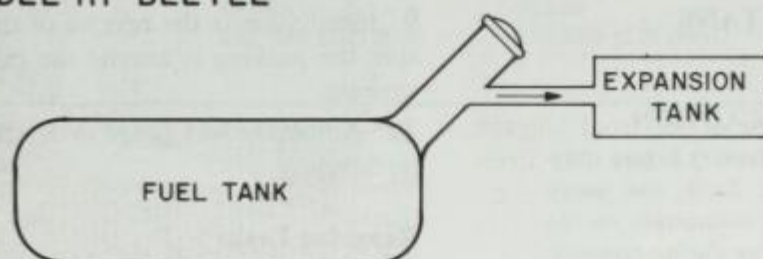


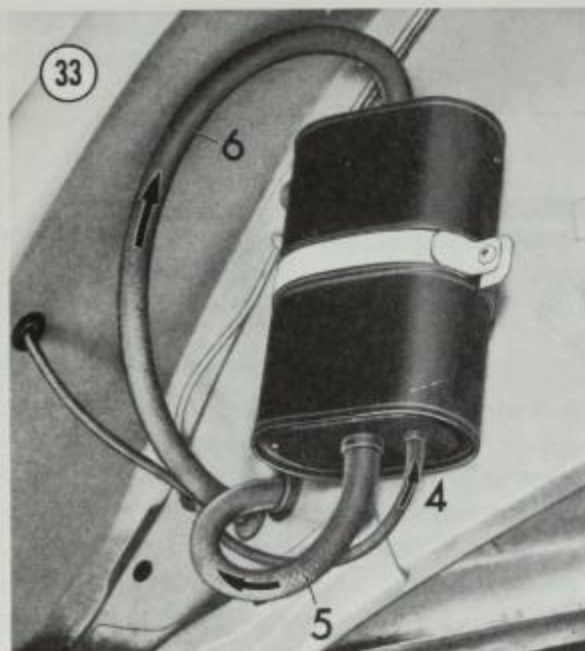
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MODEL 113 SUPER BEETLE



MODEL 111 BEETLE





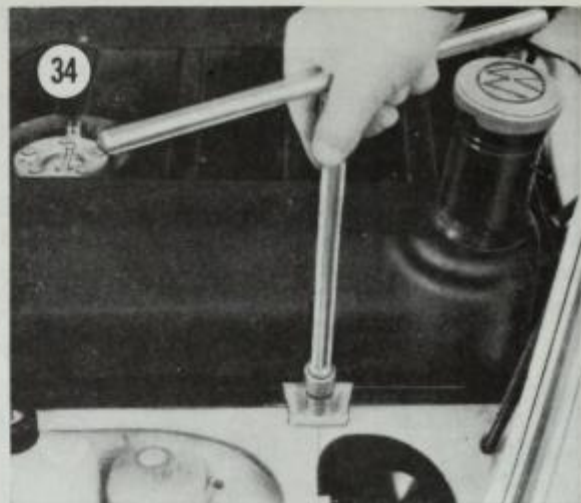
FUEL TANK

Removal/Installation

HAZARD CAUTION

Always disconnect battery before starting tank removal. Tank can easily brush against horn connection on the steering shaft housing during removal. With power connected, the resulting spark can cause a gasoline fire. It's happened many times.

1. Empty the front luggage space.
2. Remove the luggage compartment liner.
3. Lift the sender unit cover off and disconnect the cable for the fuel gauge.
4. Pull the fuel outlet hose off the line in the frame and clamp or plug it so it doesn't leak.
- 5a. On 1961-67 tanks, remove the fuel tank breather pipe.
- 5b. On 1968-72 tanks, remove the large clamp from the breather pipe boot. Remove the boot and breather pipe.
6. On Super Beetles (1971 and 1972), disconnect 3 lines to the separator. See Figure 31.



7. Remove the 4 retaining bolts (Figure 34) and lift the tank out.
8. Flush the tank with solvent and blow it out with compressed air.
9. Installation is the reverse of these steps. Be sure the packing is around the tank to prevent squeaks.
10. Adjust the fuel gauge as described in Chapter Seven.

Repairing Leaks

Fuel tank leaks may be repaired by soldering or brazing.

WARNING: *A fuel tank is a potential bomb capable of killing anyone nearby. Always observe the following safety precautions when repairing a fuel tank.*

1. Have the tank steam cleaned **inside and outside**.
2. Fill the tank with inert gas such as carbon dioxide or nitrogen or fill the tank **COMPLETELY** with water.
3. Set a fire extinguisher nearby.

After the repair is made, pour the water out, put about a quart of gasoline in the tank and slosh it around. Pour the gasoline out, blow the tank dry and install it in the car.

SPECIFICATIONS	1961-1963	1964 & 1965	1966 & 1967
CARBURETOR			
Type	28 PICT	28 PICT-1	30 PICT-1
Venturi	22.5mm	22.5mm	24mm
Main jet	122.5mm	122.5mm	0 125
Air correction jet	130Y, 145Y ¹	130Y, 145Y ²	125Z, 135Z (1967) ³ 170Z (1966) ³
Pilot jet	55	55	g 55
Pilot jet air bleed	2.0mm	2.0mm	150
Accelerator pump jet	0.50	0.50	50
Power fuel jet	1.0mm	1.0mm	— — —
Float needle valve dia.	1.5mm	1.5mm	1.5mm
Float weight	5.7 grams	5.7 grams	5.7 grams
Accelerator pump feed	1.1-1.4cc/stroke	1.1-1.4cc/stroke	1.3-1.6cc/stroke
FUEL PUMP			
Delivery pressure (max)	2.8 psi	4 psi	4 psi
Delivery capacity (min)	400cc/min. @ 3400 rpm	400cc/min. @ 3800 rpm	400cc/min. @ 3800 rpm
AIR CLEANER			
Type	Oil bath	Oil bath	Oil bath
Oil capacity	0.53 pints (0.25 liters)	0.53 pints (0.25 liters)	0.53 pints (0.25 liters) ¹ 0.8 pints (0.4 liters) ²

¹ 1300 engine ² 1500 engine ³ Karmann Ghia

SPECIFICATIONS	1968 & 1969	1970	1971 & 1972
CARBURETOR			
Type	30 PICT-2	30 PICT-3	34 PICT-3
Venturi	24mm	24mm	26mm
Main jet	0 125	X 112	X 130
Air correction jet	125Z, 135Z ¹	125Z	75Z, 80Z ²
Pilot jet	55	65	60
Pilot jet air bleed	130	135	147.5
Accelerator pump jet	50	— — —	47.5
Power fuel jet	60	— — —	100
Float needle valve dia.	1.5mm	1.5mm	1.5mm
Float weight	8.7 grams	8.5 grams	8.5 grams
Accelerator pump feed	1.3-1.6cc/stroke	1.2-1.35cc/stroke	1.45-1.75cc/stroke
FUEL PUMP			
Delivery pressure (max)	4 psi	4 psi	3-5 psi
Delivery capacity (min)	400cc/min. @ 3800 rpm	350cc/min. @ 3800 rpm	400cc/min. @ 4000 rpm
AIR CLEANER			
Type	Oil bath	Oil bath	Oil bath
Oil capacity	0.8 pints (0.4 liters)	0.8 pints (0.4 liters)	0.9 pints

¹ 1300 engine ² 1500 engine ³ Karmann Ghia

CHAPTER SEVEN

ELECTRICAL SYSTEM

Electrical systems from 1961 through 1972 are very similar. Models from 1961 through 1966 have a 6 volt negative ground system; later models used a 12 volt system. Other differences occur mainly as small design changes in the generator, regulator, starter, distributor, fuse, and lighting arrangements.

This chapter includes service procedures for the battery, starter, charging system, lighting system, fuses, instruments, and windshield wipers. Wiring diagrams for all models are included at the end of this chapter.

BATTERY

Care & Inspection

1. Disconnect both battery cables and remove the battery.
2. Clean the top of the battery with baking soda solution. Scrub with a stiff bristle brush. Wipe battery clean with a cloth moistened in ammonia or baking soda solution.

CAUTION: *Keep cleaning solution out of battery cells or the electrolyte will be seriously weakened.*

3. Clean battery terminals with a stiff wire brush or one of the many tools made for this purpose.
4. Examine entire battery case for cracks.

5. Install the battery and reconnect battery cables. Observe battery polarity.
6. Coat the battery connections with light mineral grease or vaseline after tightening.
7. Check electrolyte level and top up if necessary.

Refer to **Table 1** for battery statistics.

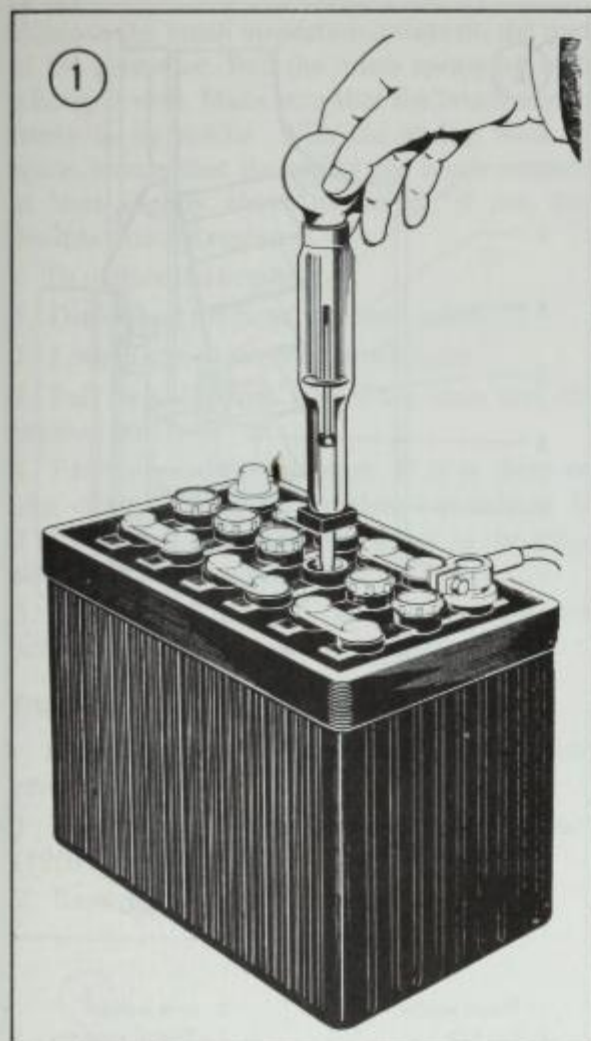
Table 1 BATTERY

	1961-1966	1967-1972
Voltage	6V	12V
Capacity	66Ah	36Ah
Ground terminal	negative	negative

Testing

Hydrometer testing is the best way to check battery condition. Use a hydrometer with numbered graduations from 1.100 to 1.300 rather than one with color coded bands. To use the hydrometer, squeeze the rubber ball, insert the tip in the cell and release the ball (see **Figure 1**). Draw enough electrolyte to float the weighted float inside the hydrometer. Note the number in line with the surface of the electrolyte; this is the specific gravity for the cell. Return the electrolyte to the cell from which it came.

The specific gravity of the electrolyte in each battery cell is an excellent indication of that



cell's condition. A fully charged cell will read 1.275-1.380, while a cell in good condition may read from 1.250-1.280. One in fair condition reads from 1.225-1.250 and anything below 1.225 is practically dead.

If the cells test in the poor range, the battery requires recharging. The hydrometer is also useful for checking the progress of the charging operation. A reading from 1.200 to about 1.225 indicates a half charge; 1.275-1.380 indicates full charge.

CAUTION: Always disconnect BOTH battery connections before connecting charging equipment.

GENERATOR

See Table 2 for a list of generators used in 1961-1972 Beetles and Karmann Ghias.

Removal

1. Disconnect negative battery cable.
- 2a. On 1961-1966 voltage regulators mounted on the generator, disconnect the small wire and mark it 61. Disconnect the large wire(s) and mark it B (51).
- 2b. On 1967-1972 models, disconnect 3 wires from generator. Mark them in accord with the labels stamped on the generator.
3. Remove the fan housing. See Chapter Five.

Table 2 GENERATOR SPECIFICATIONS

Year	Chassis No.	Generator	Voltage Regulator	Mean Regulating Voltage (Volts)	Maximum Current (Amperes)	Output Power (Watts)	Nominal Output Speed (rpm)	Pulley Ratio
1961-1964	3 192 507 - 5 967 385	BOSCH 113 903 021C	113 903 801C	7V	—	180W	2500	1.8:1
1964	5 967 386 - 6 502 399	VW 111 903 021F	113 903 801D	7V	—	180W	2500	1.8:1
1965	115 000 001 - 115 979 202	VW 111 903 021G	113 903 801D	7V	—	180W	2700	1.8:1
1966	116 000 001 - 116 1021 300	VW 111 903 021H 111 903 021J	Integrally Mounted	7V	—	180W	2700	1.8:1
1967	117 000 001 - 117 999 000	211 903 031	211 903 803	14V	30A	360W	2000	1.8:1
1968	118 000 001 - 118 857 871	211 903 031A	211 903 803B	14V	30A	—	2000	1.8:1
1968-1972	118 857 872 -	113 903 031G	113 903 803E	14V	30A	—	2000	1.9:1

4. Make small marks on the fan housing and fan cover to aid in reassembly.
5. Remove 4 screws securing the fan cover to the fan housing.
6. Remove the generator and fan assembly.
7. Remove the fan nut.
8. Pull off the fan, thrust washers, shims, and hub.
9. Remove 2 nuts securing the fan cover to the generator.

Installation

1. Install the fan cover on the generator.
2. Place the fan hub on the generator shaft. Be sure the woodruff key is seated properly.
3. Insert shims.
4. Place fan in position.
5. Install the nut and tighten to 40-47 foot-pounds (5.5-6.5 mkg).
6. Check the distance from fan to cover (a, in **Figure 2**). It should be 0.08" (2.0mm). If not, remove the nut, vary the number of shims under the thrust washer. Install the thrust washer, any unused shims, and then retorque the nut. Measure "a" again, and readjust it if necessary.
7. Reinstall the generator/fan cover assembly in the fan housing.
8. Install the fan housing. See Chapter Five.
9. Adjust the fan belt tension. See Chapter Two.

CAUTION: Polarize the generator as described below BEFORE connecting any wires. Otherwise the voltage regulator can be seriously damaged.

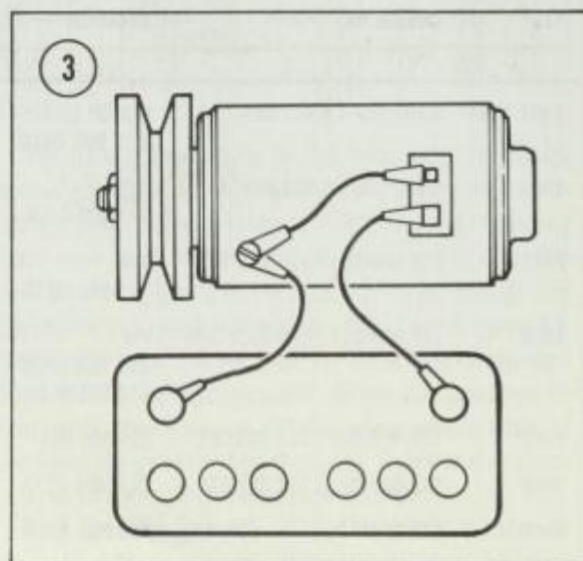
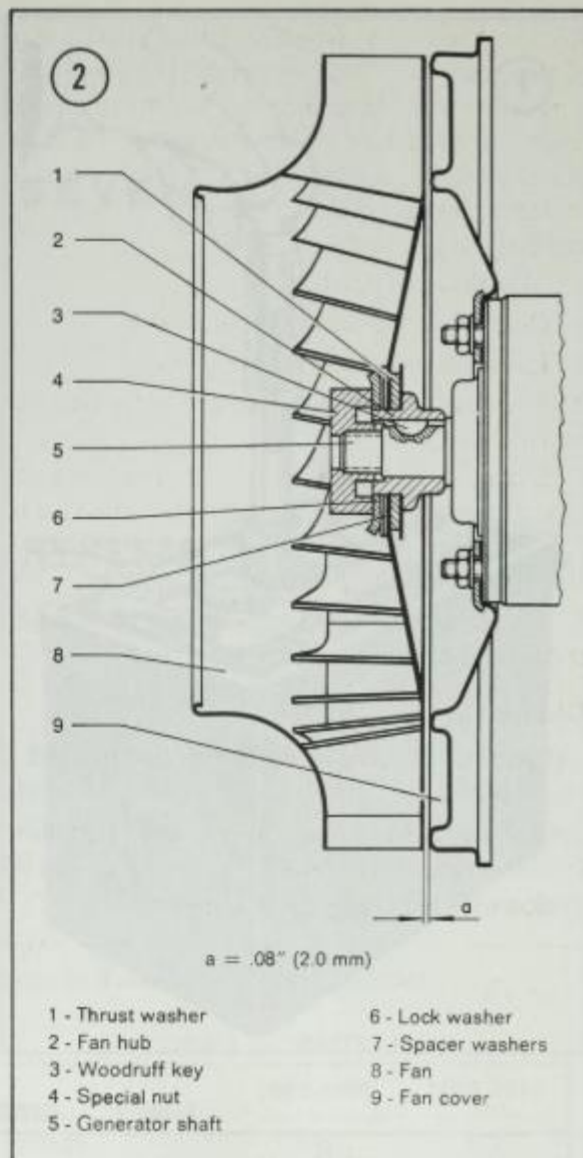
Polarizing

When either the generator or regulator has been disconnected, particularly if the generator has been rebuilt, it must be polarized. Polarizing ensures that residual magnetism in the pole shoes has correct polarity. Reversed polarity can burn out the regulator cut-out relay contacts.

To polarize the generator, connect it to a battery of the proper voltage (6 or 12 volts) as shown in **Figure 3**. Note that the voltage regulator is completely disconnected. Install the generator as described earlier.

Brush Replacement

Brushes should be checked every 6000 miles.



Remove the brush inspection covers on the rear of the generator. Pull the brush spring up with a hooked wire. Make sure that the brush moves freely in its holder. With the spring back in place, ensure that the top of the brush extends at least slightly above its holder; if not, the brushes must be replaced.

To replace the brushes:

1. Disconnect the battery ground cable.
2. Loosen screws securing brush leads.
3. Pull brush springs out of the way, and lift brushes out.
4. Examine the commutator. If it is dirty or oily, clean with a cloth moistened in solvent. If it is scored, turned or worn down to the mica strips, overhaul the generator.
5. Install new brushes in holders. Tighten screws. Always replace both brushes.

Disassembly

Refer to **Figures 4 or 5** for the following procedure.

1. Remove the drive pulley and regulator (1961--1966 only).
2. Remove both long housing screws.

3. Disconnect the field winding from the positive brush holders.

4. Lift the brushes out of the holders.

5a. On Bosch generators, remove the bearing spring ring and commutator end plate.

5b. On VW generators, remove the bearing spring ring, retaining ring, and felt ring. Remove the commutator end plate.

6. Withdraw the end plate/armature assembly from the field housing.

7. Remove the spacer, oil slinger, bearing, cup washer (Bosch generators only), and lock ring from the commutator end of the armature shaft.

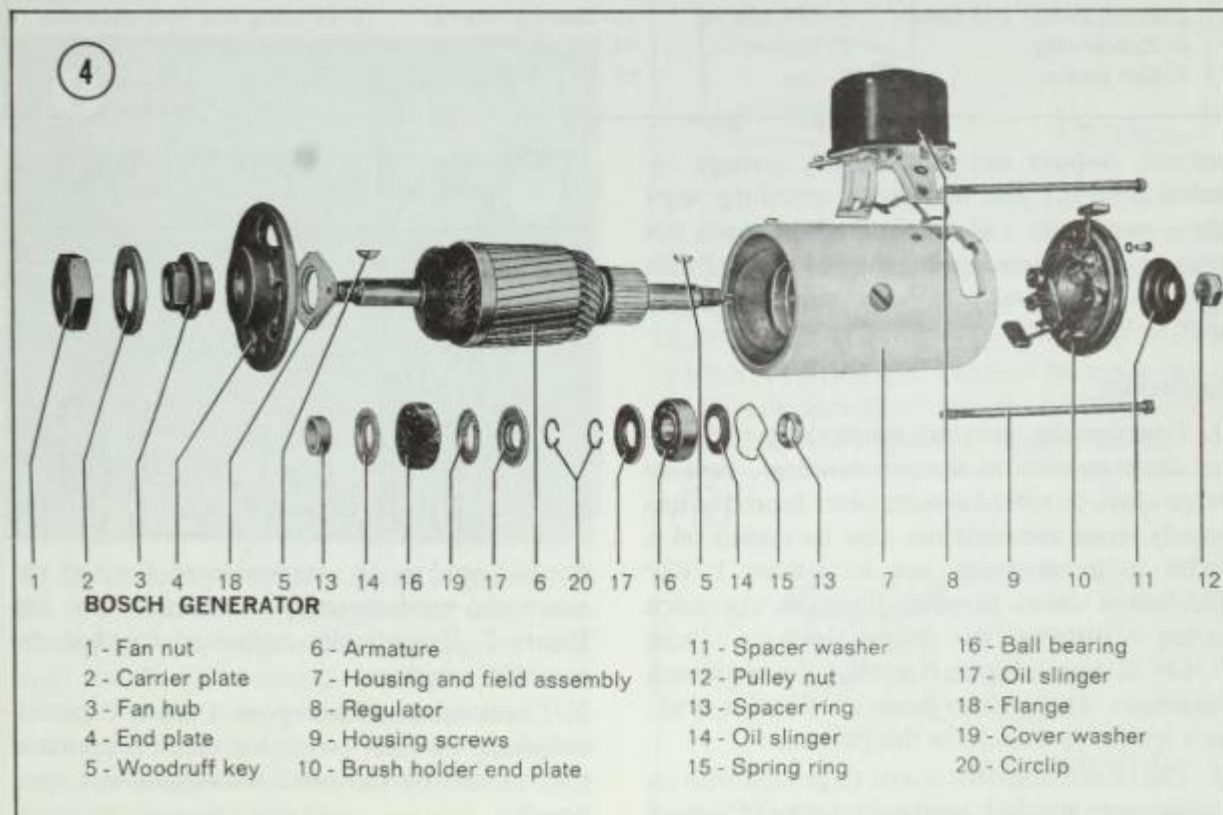
8. Press the end plate off the fan end of the armature shaft.

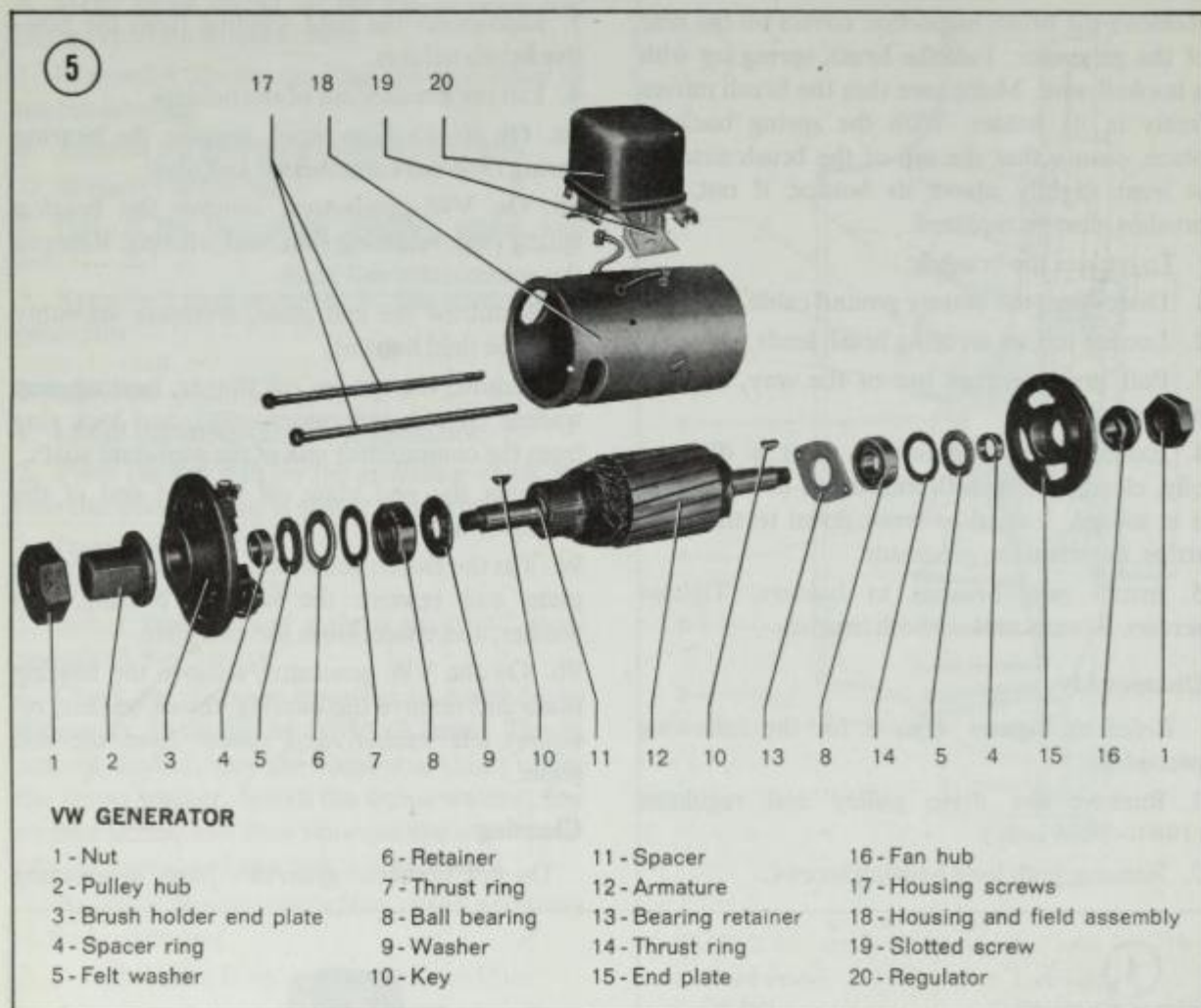
9a. On the Bosch generator, remove the bearing plate and remove the washer, bearing, cup washer, and spacer from the end plate.

9b. On the VW generator, remove the bearing plate and remove the bearing, thrust washer, retainer, felt washer, and spacer from the end plate.

Cleaning

Do not immerse generator parts in cleaning

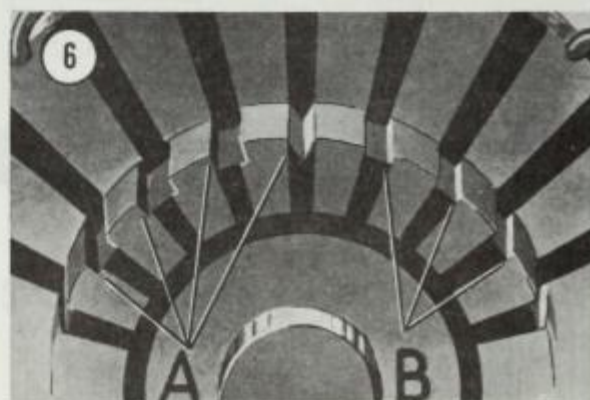




solvent. Solvent can permanently damage insulation on the field housing or armature; wipe these parts with a clean cloth. Other parts not containing insulated wiring may be cleaned with a brush moistened in solvent, then wiped dry with a clean cloth.

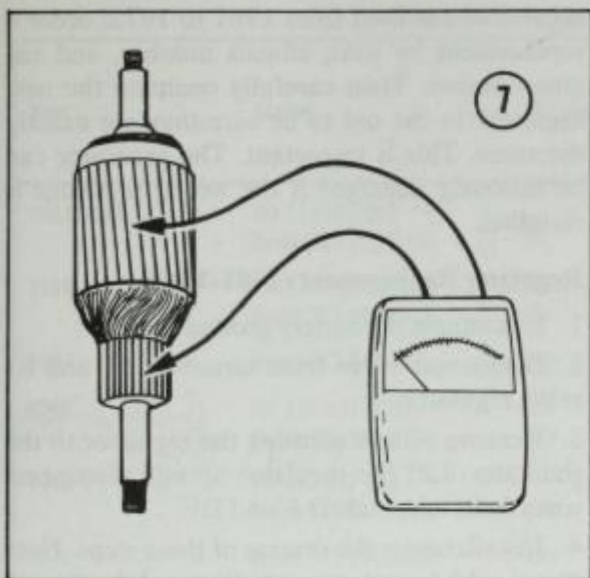
Inspection

1. Examine the armature for obvious mechanical damage such as burned windings, bent or worn shaft, or scored commutator. Scored or unevenly worn commutators may be turned on a lathe to a diameter not less than 1.292" (32.8mm). After turning, undercut the mica strips separating the brass segments about 1/64" (0.4mm). **Figure 6** shows right and wrong undercuts. Use a short piece of hacksaw blade or a special tool made for this purpose.
2. Check armature for shorts to ground with an ohmmeter or other continuity tester. Connect



one test prod to the armature core. Connect the other test prod to each commutator bar. See **Figure 7**. If continuity occurs on any bar, replace the armature.

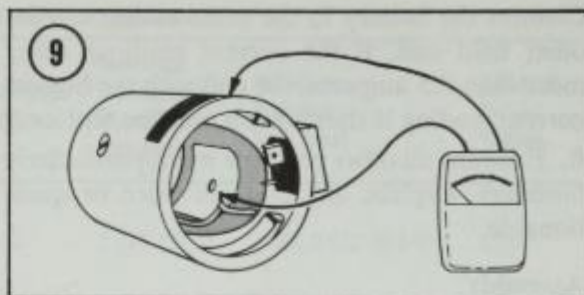
3. Check armature for opens. Usually these are evidenced by burn marks between commutator bars caused by the brushes bridging the open circuit.



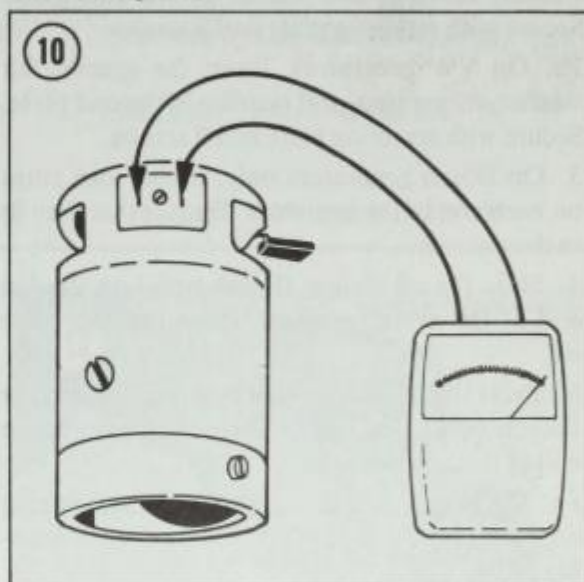
4. Check armature for winding shorts. To do this, insert the armature in a growler. Turn the growler on and hold a hacksaw blade slightly above, but not touching the armature. See **Figure 8**. Rotate the armature slowly; if the blade vibrates and is attracted to the armature, a winding is shorted. If visual inspection does not reveal a short which can be fixed, replace the armature.



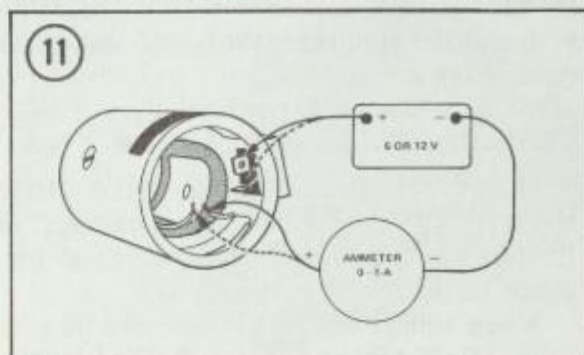
5. Check field winding for shorts to ground. To do this, connect an ohmmeter or other continuity tester between a field winding lead (coil end) and the field housing. See **Figure 9**. If continuity occurs, a field winding is shorted. Unsolder the connecting wires and test each field coil separately until the ground is traced. Replace the grounded winding.



6. Check field winding for open circuit. Connect an ohmmeter between the field terminal and the field coil lead going to the armature terminal. See **Figure 10**. Continuity should be measured; if not, a field winding is open and must be replaced.



7. Check field windings for shorts. Unsolder connecting wires and test each coil separately. To check them, connect one end of a battery (6 or 12 volt, depending on generator type) to one lead of either coil. Connect the other end of the battery through an ammeter to the other end of the coil. See **Figure 11**. Record the current.



Connect the battery in the same manner to the other field coil. If the current readings differ more than 0.5 amperes, the coil with the highest current reading is shorted and must be replaced.

8. Examine all other parts for wear, particularly bushings. Replace any that are worn or questionable.

Assembly

Refer to Figures 4 or 5 for the following procedure.

1. Pack both ball bearings with high temperature grease.
- 2a. On Bosch generators, insert the spacer, cup washer, bearing, and washer in the end plate. Secure with retaining plate and 2 screws.
- 2b. On VW generators, insert the spacer, felt washer, thrust ring, and bearing in the end plate. Secure with retaining plate and 2 screws.
3. On Bosch generators only, install lock rings on each end of the armature. Ensure that they fit in the grooves.
4. Slide the oil slinger (Bosch only) on the fan end of the armature shaft. Press the end plate on.
5. Press the oil slinger, ball bearing, cup washer (Bosch only), and spacer onto the commutator end of the armature shaft.
- 6a. On Bosch generators, install the spring ring and commutator end plate. Secure with 2 housing bolts.
- 6b. On VW generators, install felt washer, retainer, thrust ring, and commutator end plate. Screw with 2 housing bolts.
7. Connect the field winding to the brush holder and tighten the screw.
8. Install the brushes against the commutator and make sure that the springs are properly seated.
9. Install the regulator (1961-1966 only) and drive pulley.

VOLTAGE REGULATOR

There are no repairs possible on the voltage regulator. If troubleshooting procedures in Chapter Three indicate a defective voltage regulator, replace it with a new one.

A new voltage regulator must match the generator. Since numerous generators and voltage

regulators are used from 1961 to 1972, order a replacement by year, chassis number, and engine number. Then carefully compare the new regulator to the old to be sure they are exactly the same. This is important. The generator can be seriously damaged if the wrong regulator is installed.

Regulator Replacement (1961-1966)

1. Disconnect the battery ground cable.
2. Disconnect wires from terminals 51 and 61 at the regulator.
3. Remove screws securing the regulator to the generator. Lift the regulator up and disconnect wires from terminals D+ and DF.
4. Installation is the reverse of these steps. Note that the thicker wire goes to D+ and the thinner wire to DF.

Regulator Replacement (1967-1972)

1. Lift up the rear seat cushion. Disconnect the battery ground cable.
2. Sketch terminals of voltage regulator. Mark wires with terminal numbers. Remove wires.
3. Remove screws securing voltage regulator and lift it out.
4. Installation is the reverse of these steps.

STARTER

See **Table 3** for a list of starters used in 1961-1972 Beetles and Karmann Ghias.

Removal/Installation

1. Disconnect the battery ground cable.
2. Disconnect battery cable from starter solenoid terminal 30, and the small wire from terminal 50.
3. Remove bolts securing the starter to the transmission case. Withdraw the starter.
4. Installation is the reverse of these steps. Before installing, apply universal grease to the starter shaft bushing. Use VW D1a Sealing Compound between the starter and transmission case.

Brush Replacement

Brushes should be checked every 6000 miles. Brushes on VW starter may be examined by removing the inspection covers. Bosch starters

Table 3 STARTER SPECIFICATIONS

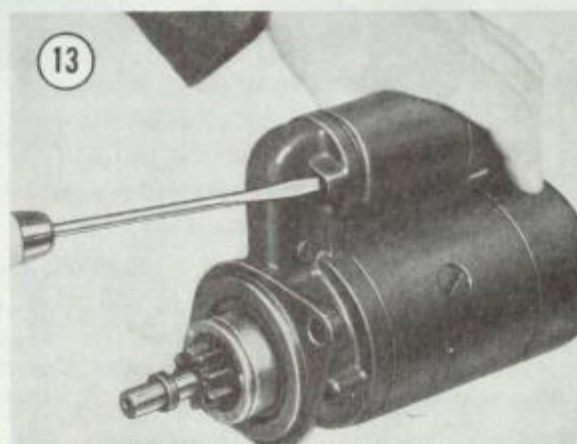
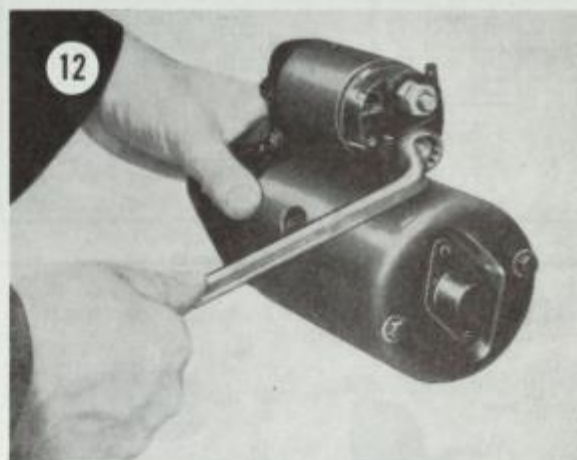
Year	Starter	Voltage	Output (hp)	Minimum Commutator Diameter inch (mm)	Armature End-play inch (mm)	Solenoid Pull-in Voltage
1961-1965	VW 113 911 021 Bosch EEF 0.5/6 L1	6V	0.5	1.319 (33.5)	0.004-0.012 (0.1-0.3)	3.3V
1966	VW 113 911 021B Bosch 113 911 021A	6V	0.5	1.299 (33)	0.004-0.012 (0.1-0.3)	3.3V
1967	Bosch 211 911 023	12V	0.7	1.319 (33.5)	0.004-0.012 (0.1-0.3)	7V
1968	VW 111 911 023A Bosch 311 911 023B	12V 12V	0.7 0.7	1.299 (33) 1.358 (34.5)	0.004-0.012 (0.1-0.3)	7V
1969	VW 111 911 023 Bosch 311 911 023B	12V	0.7	1.358 (34.5)	0.004-0.012 (0.1-0.3)	7V
1970	Bosch 311 911 023B	12V	0.7	1.358 (34.5)	0.004-0.012 (0.1-0.3)	7V
1971 & 1972	Bosch 311 911 023 B/C/D	12V	0.7	1.358 (34.5)	0.004-0.012 (0.1-0.3)	7V
All Automatic Stick Shift Models	Bosch 003 911 023A	12V	0.8	1.319 (33.5)	0.004-0.006 (0.1-0.15)	8V

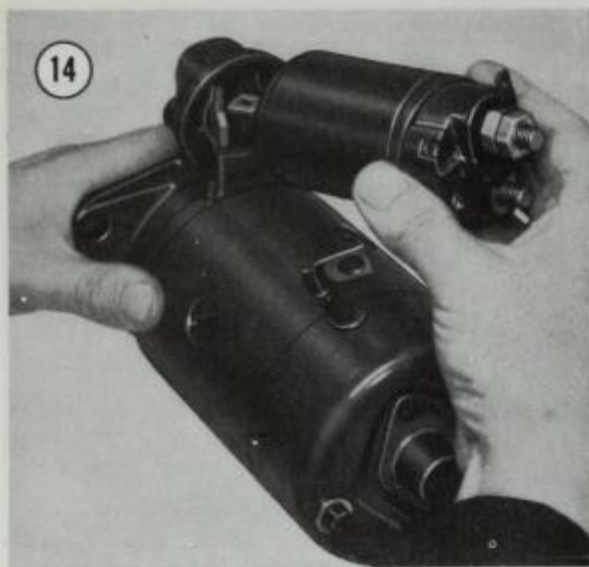
must be partially disassembled as described below. Pull on the brush leads to ensure they slide freely in their holders. Ensure the brushes are not worn; if the flexible lead is nearly touching the metal holder, all 4 brushes should be replaced.

After removing the starter as described earlier, perform steps 2-6 of the Bosch disassembly procedure or steps 2-5 of the VW disassembly procedure to expose the brushes. Unsolder all 4 brushes and solder in a set of new ones. Examine the commutator before reassembling. If it is dirty or oily, clean it with a cloth moistened in solvent. If it is scored, burned or worn down to the mica strips, overhaul the starter. Reassembly is by reversing steps 2-6 of the disassembly procedure.

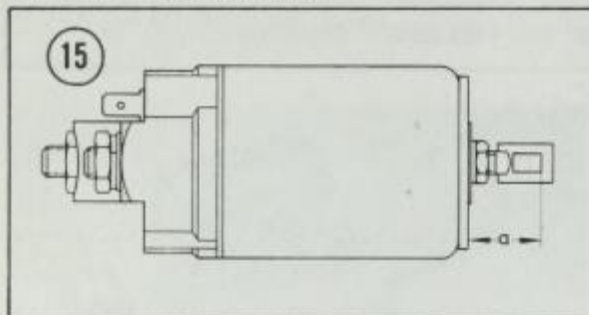
Solenoid Replacement (Bosch)

1. Disconnect the large connecting wire between starter and solenoid. See **Figure 12**.
2. Remove 2 screws securing solenoid to the mounting bracket. See **Figure 13**.
3. Lift solenoid pull rod free of the operating lever and remove solenoid (**Figure 14**).
4. Do not change pull rod adjustment if old solenoid is to be reinstalled. On new solenoids,





loosen the lock nut and adjust dimension "a" shown in **Figure 15** to 0.748 ± 0.004 " (19 ± 0.1 mm). Tighten lock nut.



5. Place a strip of VW D14 Plastic Sealer on the outer edge of solenoid face.
6. Pull the drive pinion to bring the operating lever back towards solenoid opening. Connect the pull rod to the operating lever.
7. Secure solenoid with mounting screws and reconnect large wire from starter.

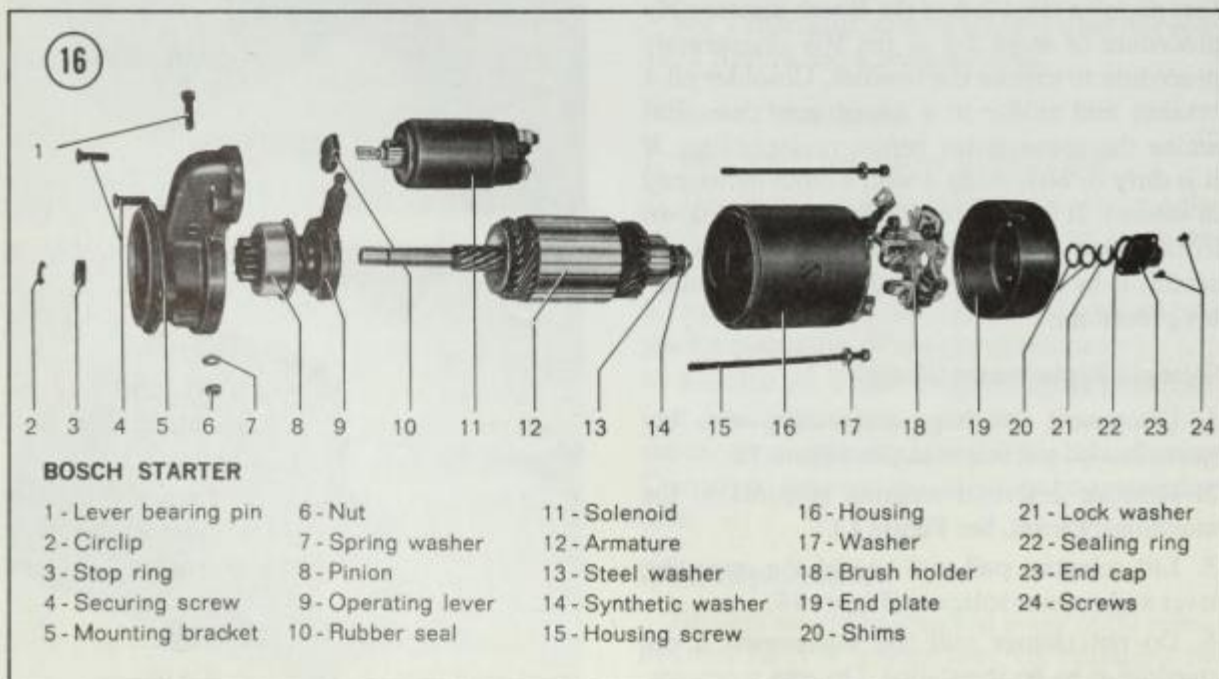
Solenoid Replacement (VW)

1. Disconnect the connecting strap from the solenoid housing.
2. Remove mounting nuts securing the solenoid housing and then the solenoid itself.
3. To reach the solenoid contacts, perform steps 2-7 of the VW disassembly procedure.
4. Reassemble by reversing these steps.

Disassembly (Bosch)

Numerous Bosch EEF series starters are used from 1961-1966. **Figure 16** is typical of all.

1. Remove solenoid as described earlier.
2. Remove end cap (23) and seal (22).
3. Pry out the lock ring (21); remove shims (20).
4. Remove cover bolts (15) and cover (19).
5. Lift brushes out of brush holder.
6. Remove brush holder.
7. Remove housing (16) from the armature/mounting bracket assembly.



8. Hold the armature in a vise with soft jaws (copper, wood blocks), commutator end down. With a hollow drift, tap stop ring (3) down away from lock ring (2).

9. Pry off lock ring (2); slide stop ring (3) off.

10. Remove any burrs around the lock ring groove. Slide mounting bracket (5) and pinion assembly (8 & 9) off the armature.

11. Remove operating lever pin (1) from the mounting bracket and remove pinion assembly.

Cleaning & Inspection

Clean all parts, carefully following the same procedure provided for the generator. Inspection is also identical to the generator inspection procedure.

Bushing Replacement (Bosch)

1. If either the mounting bracket bushing or end cover bushing is scored or worn, drive out the old bushing with a suitable drift.

2. Clean out the bushing hole, and remove any burrs.

3. Soak new bushings in hot light oil for at least an hour.

4. Install bushings with a suitable drift.

Assembly (Bosch)

Refer to Figure 16 for the following procedure.

1. Mount the drive pinion with operating lever on the mounting bracket with operating lever pin (1).

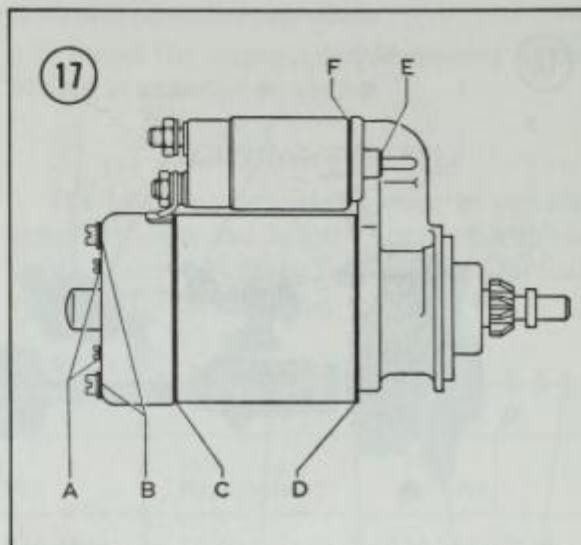
2. Grease all bearing surfaces with universal grease, and guide the armature shaft into the drive pinion.

3. Push on the stop ring and install the lock ring. Pull the stop ring over the lock ring. It should be possible to turn the stop ring on the shaft without jamming.

4. Install rubber seal in mounting bracket and fit the starter housing. Ensure that the tab on the housing locates in the mounting bracket slot. Use sealing compound at D in Figure 17.

5. Slide steel washer (13) and fiber washer (14) on the armature shaft.

6. Install the brush holder on the commutator and insert the brushes.



7. Lubricate the bushing in end cover (19) with oil. Install the end cover on the housing and secure with long screws to the mounting bracket. Use sealing compound at B and C in Figure 17. Ensure that the rubber grommet on the wire to the solenoid fits properly in the cover.

8. Install shims (20) and lock ring (21). Check shaft end play, which should be 0.004-0.012" (0.1-0.3mm). Adjust by adding or removing shims (20).

9. Install a new seal (22) and install the end cap. Use sealing compound at A in Figure 17.

10. Install the solenoid as described earlier.

Disassembly (VW)

Refer to Figure 18 for the following procedure.

1. Remove the starter solenoid as described earlier.

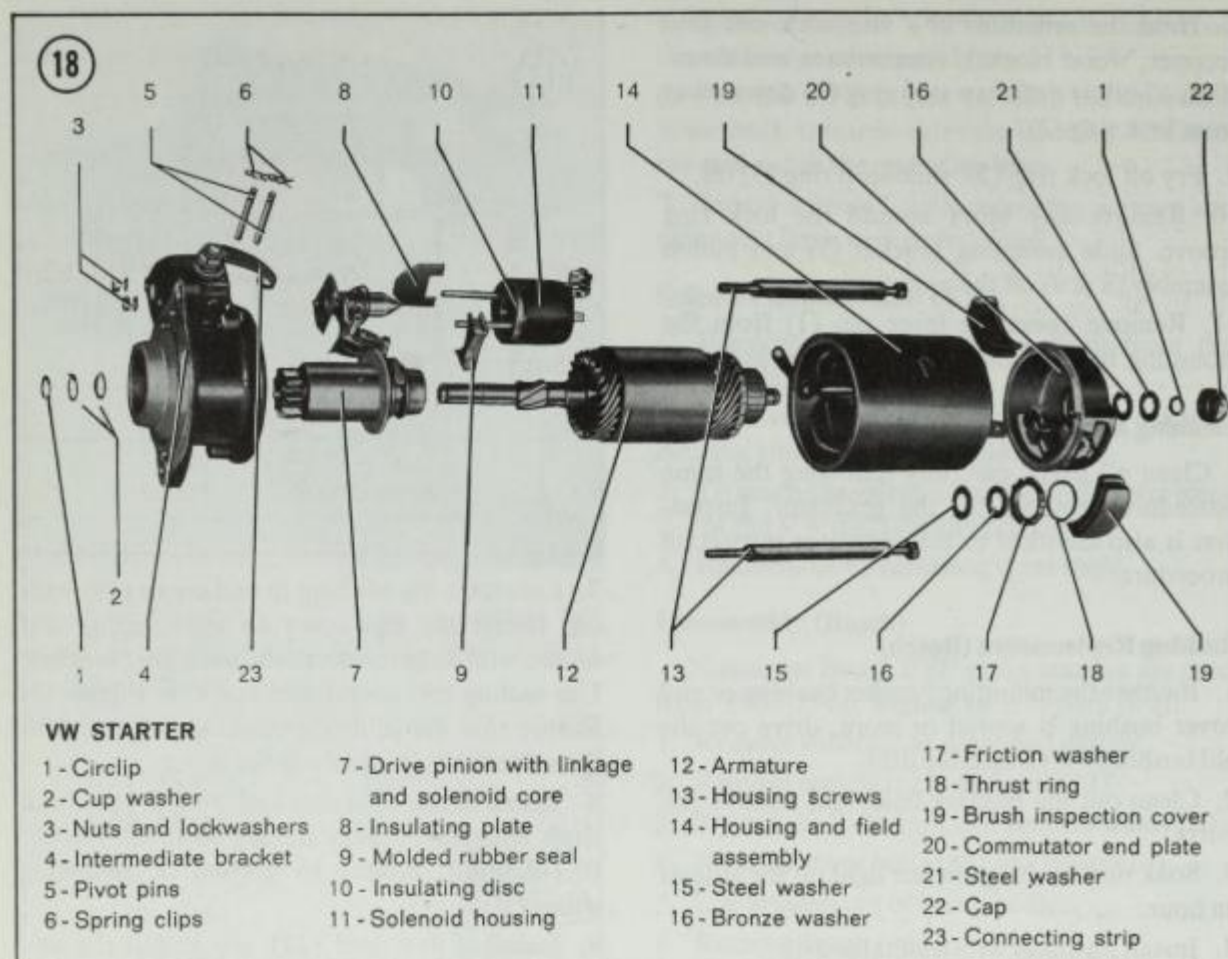
2. Remove end cap (22), lock ring (1), steel washer (21), and bronze washer (16). Remove burrs from the lock ring groove.

3. Remove brush inspection caps (19). Lift the carbon brushes out of their holders.

4. Remove housing bolts (13), and pull off mounting bracket (4) with armature (12). Note the number of shims (15 & 16).

5. Disconnect the field coil from the positive brush holder and pull commutator end plate (20) off. Take out friction washer (17) and thrust ring (18).

6. Remove spring clips (6) from the operating lever pivot pins (5). Press the pins out.



7. Remove insulating plate (8), and turn the contact plate of the solenoid plunger 90°. Remove mounting bracket (4) from the armature/pinion assembly.

8. Remove lock ring (1) from the armature shaft. Slide both cup washers (2) off.

9. Pull the plastic shift collar on the drive pinion assembly away from the overrunning clutch about 3/16" (5mm) and pull the clutch off the armature shaft. A turning, jerking motion is usually necessary.

10. Remove the shift collar and 5 steel balls from the overrunning clutch.

Cleaning & Inspection (VW)

The generator cleaning and inspection procedures described earlier are equally applicable to the VW starters.

Assembly (VW)

Refer to Figure 18 for the following procedure.

1. Lubricate the steel balls with universal grease and insert them in the overrunning clutch.

2. Slide the plastic shift collar onto the armature shaft.

3. Slide the overrunning clutch onto the armature shaft and push firmly to ensure the inner spring passes over the shaft shoulder and into the groove.

4. Slide both cup washers (2) onto the shaft and install lock ring (1).

5. Place the shift lever and solenoid core on the shift collar. Install the mounting bracket over the pinion assembly. Install insulating plate (8) and secure the shift lever with both pivot pins. Install the spring clips on the pins.

6. Install the starter housing over the armature. Slide a steel washer (15) and bronze washer (16) over the commutator end of the armature shaft.

7. Fit thrust ring (18) and fiber washer in the commutator end cover.

8. Install the commutator end cover (20) and housing bolts (13).
9. Slide bronze washer(s) (16) and steel washer (21) onto armature shaft. Install lock ring (1).
10. Check the shaft end play which, should be 0.004-0.012" (0.1-0.3mm). Adjust by adding or removing bronze washers. Install end cap (22) and insert the brush inspection covers.
11. Install the starter solenoid housing as de-

scribed in an earlier procedure.

12. Install the starter solenoid housing as described in an earlier procedure.

LIGHTING SYSTEM

The following procedures describe replacement of lamps and relays associated with the lighting system. Refer to **Tables 4 and 5** for bulb type used for each function.

Table 4 BULBS, BEETLE

Function	6V		12V	
	U.S. Replacement	VW Part No.	U.S. Replacement	VW Part No.
Headlights	6006	111 941 161A	6012	111 941 261A
Front turn signals	1129	N 17 731 1	1034	N 17 738 2
Front parking lights	81	N 17 719 1	1034	N 17 738 2
Side marker lights	- - -	- - -	57	N 17 717 2
Stop/tail lights	1154	N 17 737 1	1034	N 17 738 2
Rear turn signals	1129	N 17 731 1	1073	N 17 732 2
License plate light	81	N 17 719 1	89	N 17 719 2
Backup lights	- - -	- - -	1073	N 17 732 2
Interior light	- - -	N 17 723 1	- - -	N 17 723 2
Instrument lights	- - -	N 17 722 1	- - -	N 17 722 2
Warning lights	- - -	N 17 725 1	- - -	N 17 725 2

Table 5 BULBS, KARMANN GHIA

Function	6V		12V	
	U.S. Replacement	VW Part No.	U.S. Replacement	VW Part No.
Headlights	6006	111 941 161A	6012	111 941 261A
Front turn signals/ parking lights	1129	N 17 731 1	1073	N 17 732 2
Stop lights	1129	N 17 731 1	1073	N 17 732 2
Tail lights	81	N 17 719 1	67	N 17 718 2
Rear turn signals	1129	N 17 731 1	1073	N 17 732 2
License plate light	81	N 17 719 1	89	N 17 719 2
Backup lights	- - -	- - -	1073	N 17 732 2
Interior light	- - -	N 17 723 1	- - -	N 17 723 2
Instrument lights	- - -	N 17 722 1	- - -	N 17 722 2
Warning lights	- - -	N 17 725 1	- - -	N 17 725 2

Headlight Replacement (1961-1966) Beetle & Karmann Ghia

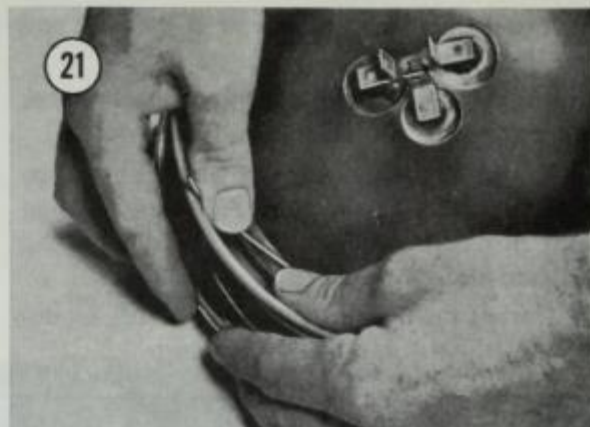
1. Loosen large screw at bottom of the trim ring. See **Figure 19**. Pull entire headlight assembly out as shown in **Figure 20**, and disconnect the cable.



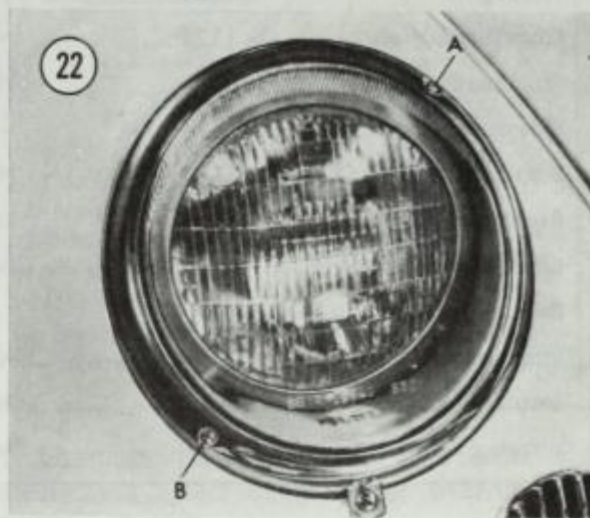
2. Disconnect parking light cables.
3. Unscrew the parking light socket.
4. Remove the headlight retaining springs as shown in **Figure 21**.

WARNING: *Springs are under considerable tension. Hold spring with one hand while unhooking it with the other to prevent springs from flying out.*

5. Withdraw the retaining spring and remove the headlight.

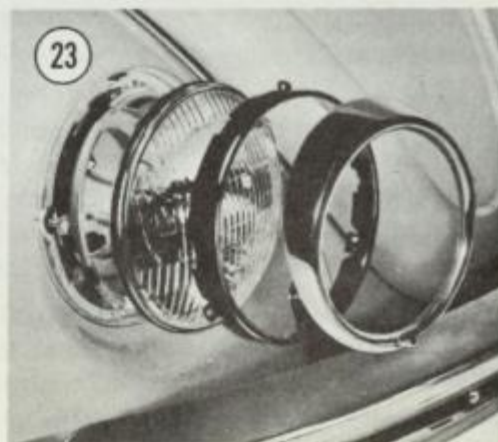


6. Installation is the reverse of these steps. Adjust headlights according to local traffic regulations. Adjusting screws are shown in **Figure 22**.

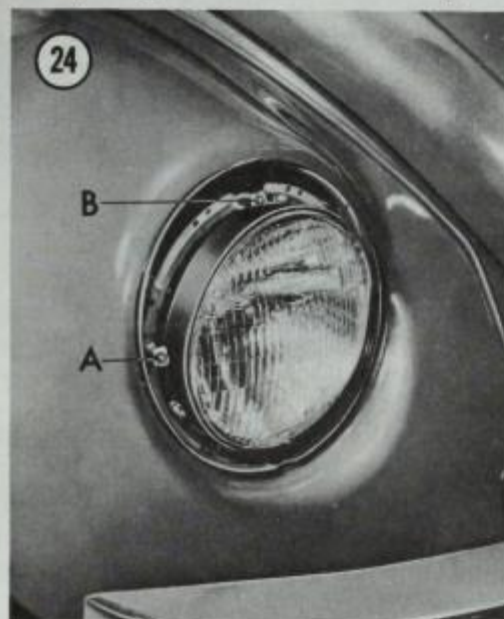


Headlight Replacement (1967-1972) Beetle & Karmann Ghia

1. Remove the screw at the bottom of the trim ring and remove the ring. See **Figure 23**.

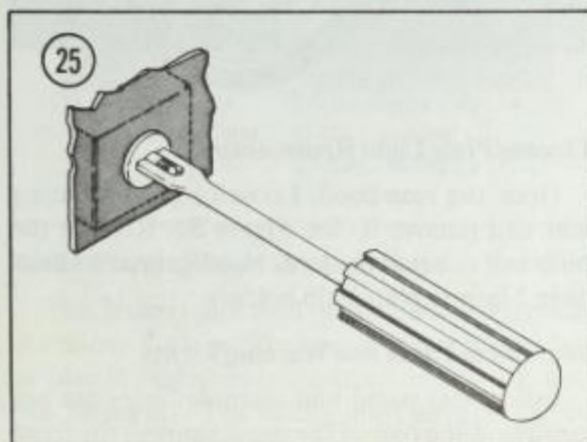


2. Remove 3 screws securing the retaining ring and remove the ring.
3. Withdraw the headlight and disconnect the cable.
4. Installation is the reverse of these steps. Adjust headlights according to local traffic regulations. Adjusting screws are shown in **Figure 24**.



Headlight Switch Replacement

1. Disconnect the battery ground cable.
2. Open the front hood and remove the protective cover over the instrument panel.
3. Sketch the switch terminals indicating wire color. Mark wires with terminal number. Remove wires from the switch.
4. Unscrew the instrument panel knob. Unscrew the retaining ring with a special tool shown in **Figure 25**. Pull the switch out.



5. Installation is the reverse of these steps. Connect wires correctly according to your sketch.

Headlight Dimmer Relay Replacement (except Super Beetle)

The dimmer relay is mounted on the steering column support behind the instrument panel next to the directional signal flasher. The dimmer relay is usually round, while the flasher relay is usually square. Another means of identification is wire color; one wire to the dimmer relay is yellow.

1. Disconnect the battery ground cable.
2. Open the front hood and remove the instrument panel protective cover.
3. Sketch the relay terminals. Mark wires with terminal number. Remove wires.
4. Remove relay from bracket.
5. Installation is the reverse of these steps.

Headlight Dimmer Relay Replacement (Super Beetle)

The dimmer relay plugs into a special bracket behind the fuse box. The dimmer relay is mounted on the left edge of the bracket as viewed from the front of the car.

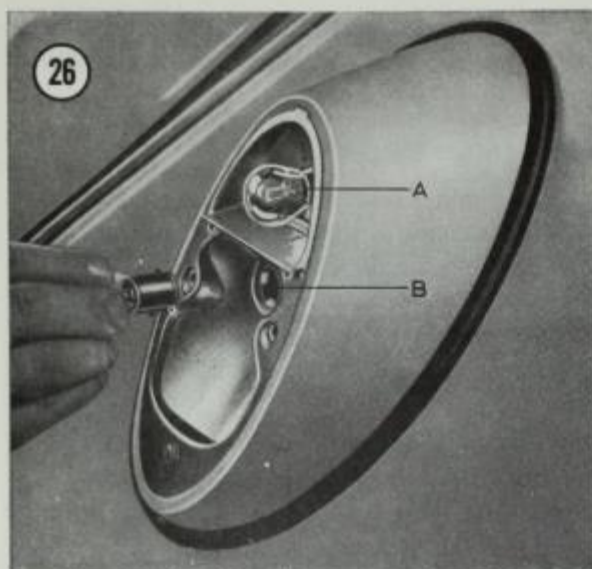
1. Open the front hood and remove the protective cover over the instrument panel.
2. Unplug the relay from the bracket.
3. Installation is the reverse of these steps.

Taillights

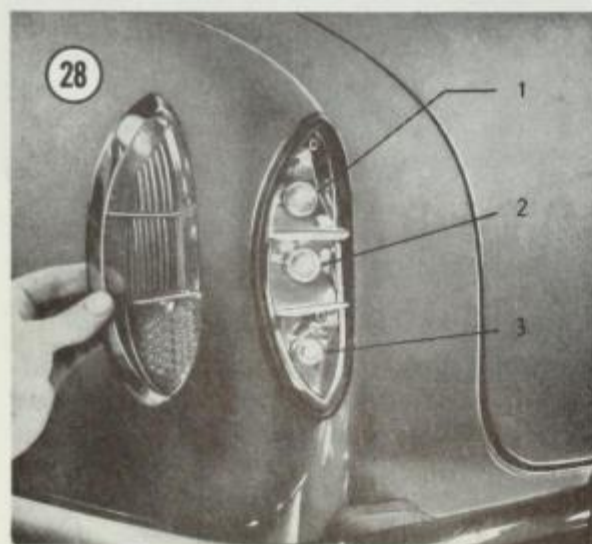
To replace the rear turn signal, brake, or back up lamps (1968-1972 only), remove screws securing the lens and remove the lens. The function of each bulb is shown in **Figure 26** (1961-1967 Beetle), **Figure 27** (1968-1972 Beetle), and **Figure 28** (Karmann Ghia). Replace the lens, but do not overtighten the screws or the lens may crack.

Front Parking, Turn & Side Marker Lights

Lamp placement differs with year. On 1961-1966 models, the front parking lamps are located in the headlight assemblies and are accessible once the assembly is removed. See Headlight Replacement. Turn signals lamps are located in a fender mounted assembly. To replace a lamp, remove the screw securing the

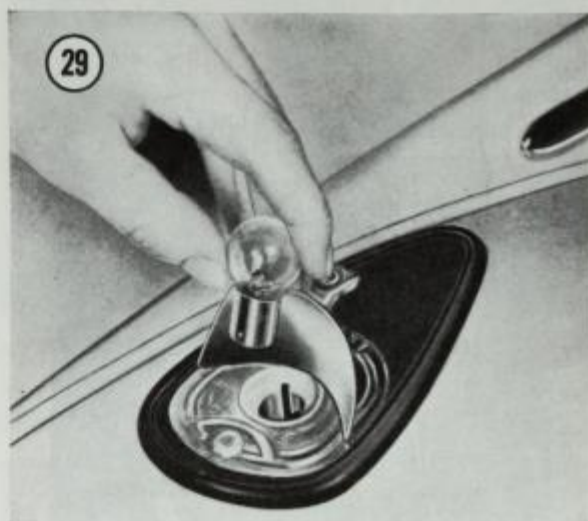


A - Turn indicator B - Stop/tail light

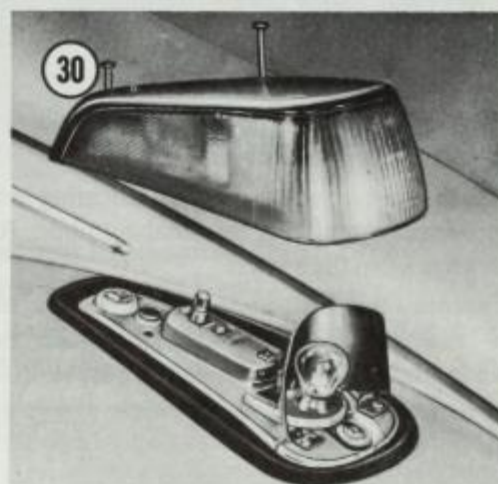


1. Turn indicator 2. Stoplight 3. Taillight

lens and lift the lens off. See **Figure 29**. Replace the lamp and lens. There are no side marker lamps from 1961-1966.



On 1967-1972 models, front parking, turn and side marker lamps are located in the same fender mounted assembly. To replace any of the lamps, remove 2 screws securing the lens and lift it off. Replace the lamp and secure the lens. See **Figure 30**.

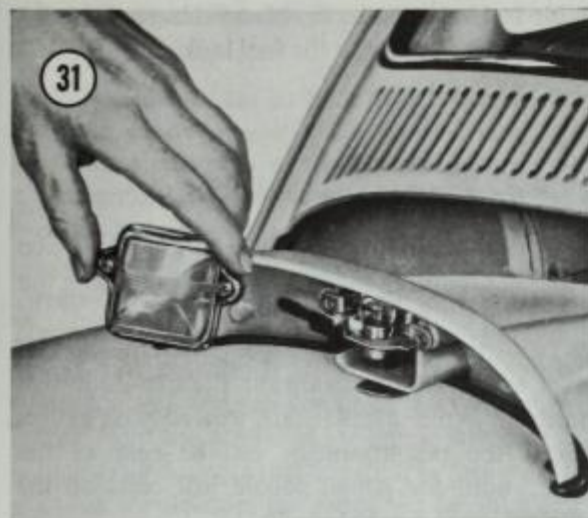


License Plate Light Replacement

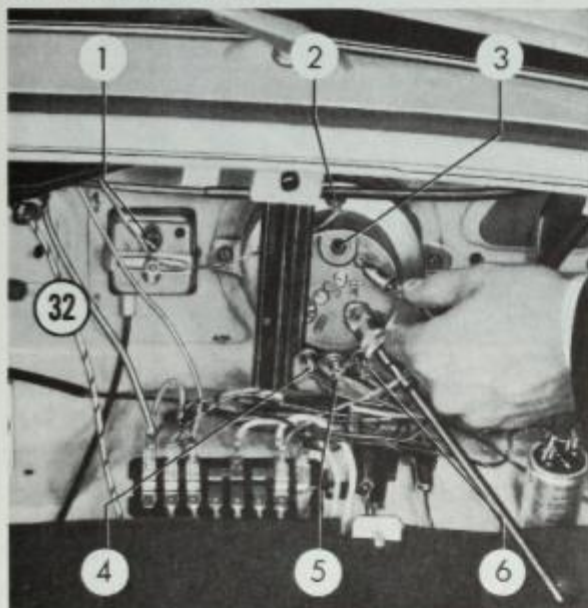
Open the rear hood. Loosen screws securing lens and remove it. See **Figure 31**. Replace the bulb and reinstall the lens. Note Karmann Ghias have 2 license plate bulb holders.

Instrument Panel and Warning Lights

Instrument panel and warning lights are accessible at the rear of the panel through the front



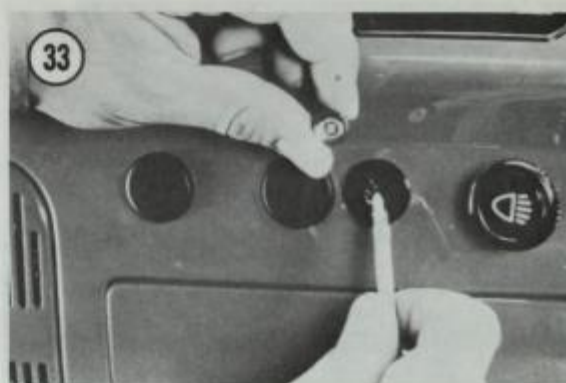
luggage compartment. All lamps except the lamp for the separate fuel gauge (1962-67) are on the rear of the speedometer. Pull the holder out and replace the lamp. Push the holder firmly back in. See **Figure 32**.



- | | |
|-----------------------|----------------------------|
| 1 - Fuel gauge light | 3 - Headlights (high beam) |
| 2 - Speedometer light | 4 - Oil pressure |
| | 5 - Turn indicators |
| | 6 - Generator |

Brake Warning Light Replacement

This lamp is mounted on the dash. To replace it, remove the lens. Slip a piece of flexible rubber or plastic tubing over the lamp and pull it out. See **Figure 33**. The tubing must have an inside diameter of 5mm to firmly grip the lamp.



Interior Light Replacement

To replace the interior lamp, pull the entire assembly out of the roof member. Replace the lamp and install the holder back in the roof. Don't damage the headliner.

INSTRUMENTS

Speedometer Removal/Installation

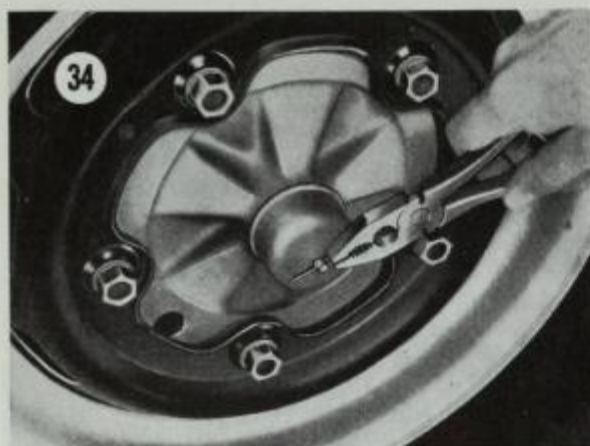
1. Disconnect the negative cable from the battery.
2. Open the front hood. Remove the protective cover over the instrument panel.
3. Pull out warning bulbs and instrument lamp from the speedometer case.
4. Unscrew the speedometer cable and remove it from the speedometer case.
5. Loosen the screws securing the speedometer case. Remove the case from the instrument panel.

NOTE: On Karmann Ghias, you must remove the steering wheel and turn signal switch before removing the speedometer case. See Chapter Eleven.

6. Installation is the reverse of these steps.

Speedometer Cable Replacement

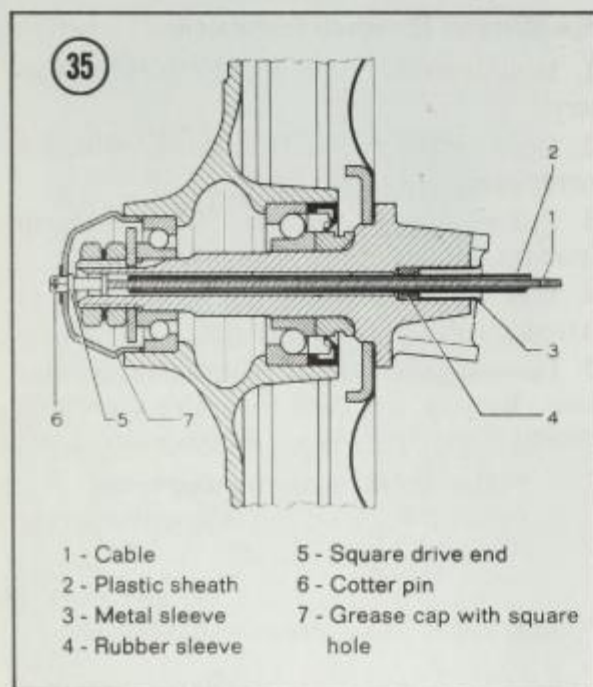
1. Open the front hood. Remove the protective cover over the instrument panel.
2. Unscrew the speedometer cable and remove it from the instrument cluster.
3. Remove the left front hub cap.
4. Remove the cotter pin securing the cable to the dust cap. See **Figure 34**.
5. Pull the cable out of the stub axle.



6. Pull the speedometer end of the cable out of the guide channel and grommet.

7. Push the new cable down into the guide channel through the grommet. Do not kink or strain the cable.

8. Slide a new rubber sleeve over the cable and insert the cable into the stub axle. (Figure 35).



9. Secure the cable to the dust cap with a new cotter pin.

10. Screw the cable onto the speedometer case.

Fuel Gauge (1962-1967)

This gauge is mechanically operated by a cable from the sender. To replace the sender, remove the luggage compartment cover and remove the cap over the sender. Disconnect the

cable from the sender lever and remove 5 screws securing the sender to the fuel tank.

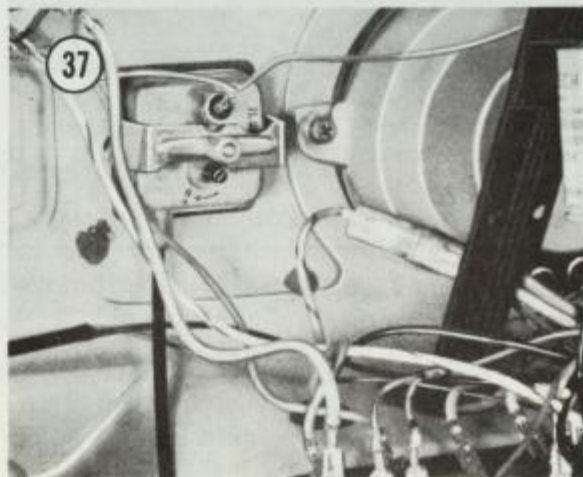
WARNING: Fuel in the tank is exposed when the sender is removed. Avoid open flames or cigarettes until the sender is replaced.

The sender is installed by securing it in place with the mounting screws. Before connecting the cable, the gauge must be adjusted.

To adjust the fuel gauge, press the sender lever to the rear to bring the float to its lowest position. While an assistant watches the gauge, adjust the potentiometer on the rear of the gauge until the gauge needle just rests on the stop below R. See Figure 36.



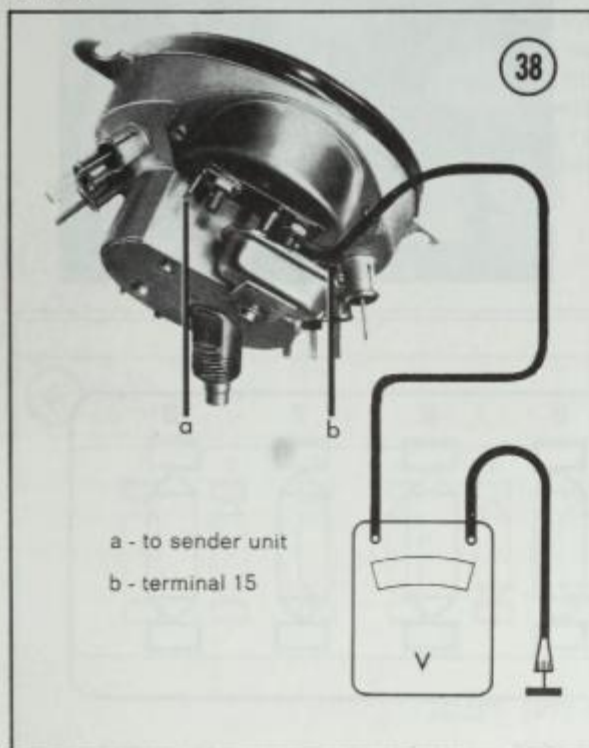
To remove the fuel gauge, unscrew the knurled nut and bracket over the gauge. See Figure 37. Pull the gauge out of the panel from the interior. Adjust the gauge when it is reinstalled.



Fuel Gauge (1968-1972)

The newest fuel gauge has an electrical sender, and a fuel gauge which is in the speedometer case.

All components of the fuel gauge system can be checked without removal. To check the replaceable vibrator in the speedometer case, connect a voltmeter as shown in **Figure 38** and turn the ignition switch on. As long as the voltmeter reading pulsates, the vibrator is good; if it does not pulsate, replace it. If the vibrator is good, check the fuel gauge by disconnecting the wire from the sender at the gauge terminal. Momentarily connect this terminal to ground. If the gauge needle does not move, replace the gauge. If the gauge is good, reconnect the wire to the gauge. The trouble must be in the wire or the sender.



To replace the sender, disconnect the negative cable at the battery. Disconnect the wire to the sender. Remove screws securing the sender to the top of the fuel tank. Super Beetle senders are not secured by screws; twist the sender counter-clockwise to remove.

WARNING: Fuel in the tank is exposed when the sender is removed. Avoid open flames or cigarettes until the sender is replaced.

Clock Replacement (Karmann Ghia Only)

1. Disconnect negative battery cable.
2. Remove protective cover over instrument panel.
3. Pull out bulbs and disconnect wire from clock.
4. Remove 2 screws securing the clock.
5. Remove clock from the instrument panel.
6. Installation is the reverse of these steps.

DIRECTIONAL SIGNALS**Directional Signal Switch Removal/Installation**

1. Disconnect the battery ground cable.
2. Remove steering wheel as described in Chapter Eleven.
3. Remove 4 screws securing the switch.
4. Lift the switch out.
5. Disconnect electrical connections.
6. On 1972 models, disconnect windshield washer hose from the combination directional signal/wiper switch.
7. Installation is the reverse of these steps.

Flasher Relay Replacement (except Super Beetle)

The flasher relay is mounted on the steering column support behind the instrument panel next to the headlight dimmer relay. The flasher relay is usually square while the dimmer relay is usually round. Another means of identification is wire color; 2 wires to the flasher relay are red.

1. Disconnect the battery ground cable.
2. Open the front hood and remove the instrument panel protective cover.
3. Sketch the relay terminals, and mark the wires with terminal numbers. Remove wires.
4. Remove relay from bracket.
5. Installation is the reverse of these steps.

Flasher Relay Replacement (Super Beetle)

The flasher relay plugs into the center of a special bracket behind the fuse box.

1. Open the front hood and remove the protective cover over the instrument panel.
2. Unplug relay from the bracket.
3. Installation is the reverse of these steps.

Lamp Replacement

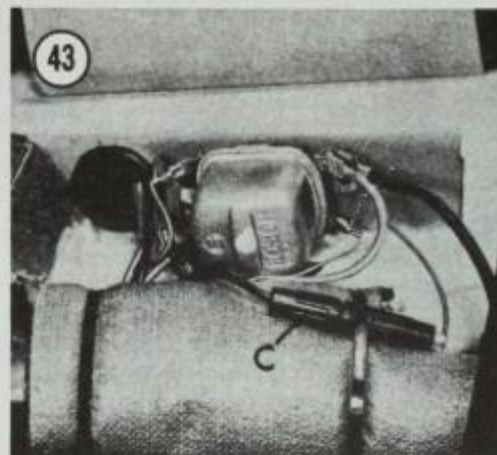
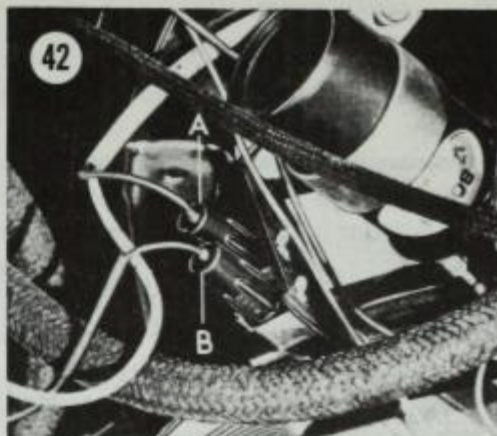
Front turn signal lamps are mounted on the front fenders. See Front Parking, Turn and Side Marker Light procedure given earlier.

Rear turn signal lamps are part of the brake lights. See Tail Light procedure provided earlier.

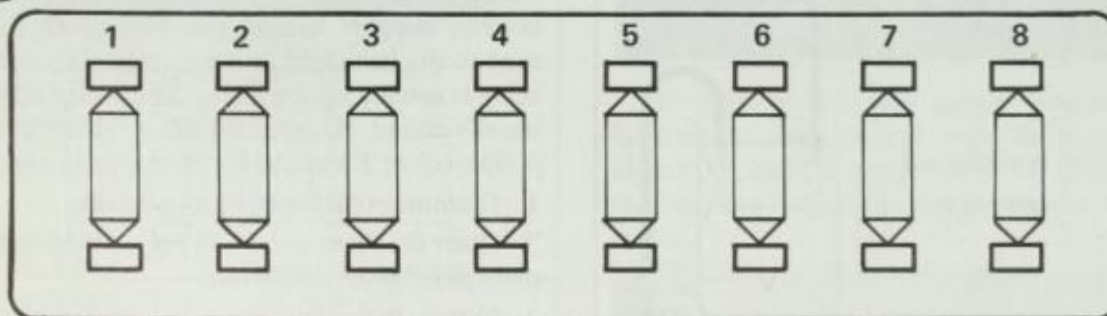
FUSES

The main fuse box normally is located under the dash to the right of the steering column. It is mounted on the left on Super Beetles. On air conditioned cars, the fuse box is located behind the instrument panel, and is accessible behind the protective cover in the front luggage compartment. **Figures 39 through 41** show the function of each fuse in the main fuse box.

Cars with optional equipment have additional fuses. Two fuses in special holders near the ignition coil protect the back up lights (A) and automatic Stick Shift Control Valve (B). See **Figure 42**. Both are 8 ampere fuses. Another special holder under the rear seat protects the rear window defogger (1969-72). See **Figure 43**. This fuse carries the main current for the window; a fuse in the main fuse box carries current for the window switch.



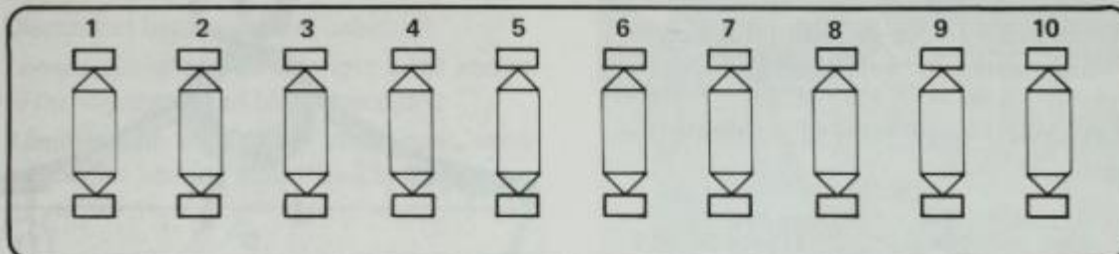
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FUSES 1961-1966

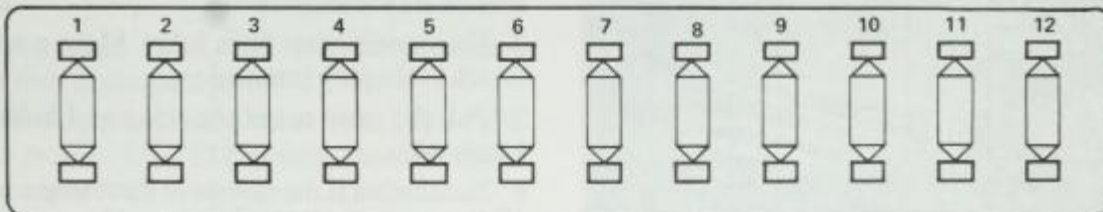
- | | | |
|--|--|---|
| 1. 8 ampere
Brake lights
Turn signals
Windshield wipers
Horn (except 1961) | 4. 8 ampere
Left low beam
5. 8 ampere
Right low beam
6. 8 ampere
Left tail light
Left front parking light
(except 1966) | 7. 8 ampere
Right tail light
License plate light
Right front parking light
(except 1966)
8. 8 ampere (1961-1965)
16 ampere (1966)
Radio
Interior light
Horn (1961 only)
Emergency flasher (1966 only) |
| 2. 8 ampere
Left high beam
High beam warning light | | |
| 3. 8 ampere
Right high beam | | |

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**FUSES 1967-1972 (except Super Beetle)**

- | | | |
|---|--|---|
| 1. 8 ampere
Horn (except 1968)
Turn signals
Brake lights (except 1969-1970)
Fuel gauge (except 1967)
Automatic Stick Shift warning lights (except 1967)
Rear window defroster switch (1969-1970 only) | 4. 8 ampere
Right high beam
5. 8 ampere
Left low beam
6. 8 ampere
Right low beam
7. 8 ampere
Right tail light (1967 & 1968 only)
Left tail light (1969 & 1970 only)
License plate light (1967 only)
Left front parking light (except 1967) | 8. 8 ampere
Left tail light (1967 only)
Right tail light (except 1967)
Right front parking light (except 1967)
License plate light (except 1967)
9. 8 ampere (1967)
16 ampere (1968-1971)
Radio (1967 only)
Interior lamp (except 1967)
Emergency flasher (except 1967)
Ignition warning light (1969 & 1970)
10. 8 ampere (1968-1971)
16 ampere (1967)
Interior lamp (1967 only)
Emergency flasher (1967 only)
Radio (except 1967) |
| 2. 8 ampere
Windshield wipers
Brake lights (1969-1970 only)
Horn (1967 only) | | |
| 3. 8 ampere
Left high beam
High beam warning light | | |

41

**FUSES 1971 & 1972 (Super Beetle)**

- | | | |
|---|---|---|
| 1. 8 ampere
Turn signals
Speedometer warning lights
Fuel gauge | 4. 8 ampere
Emergency flasher
5. 8 ampere
Unassigned
6. 8 ampere
Interior light
Ignition buzzer | 9. 16 ampere
Left low beam |
| 2. 8 ampere
Windshield wipers
Brake warning light
Automatic stick shift warning lights
Rear window defroster switch | 7. 8 ampere
Left high beam
High beam warning light | 10. 8 ampere
Right low beam |
| 3. 8 ampere
Brake lights
Horn | 8. 8 ampere
Right high beam | 11. 16 ampere
Left tail light |
| | | 12. 8 ampere
Right tail light
Side marker lights
License plate light |

Whenever a fuse blows, ascertain the reason for the failure before replacing the fuse. Usually the trouble is a short circuit in the wiring. This may be caused by worn-through insulation or a wire which works its way loose and shorts to ground.

Carry several spare fuses in the glove compartment.

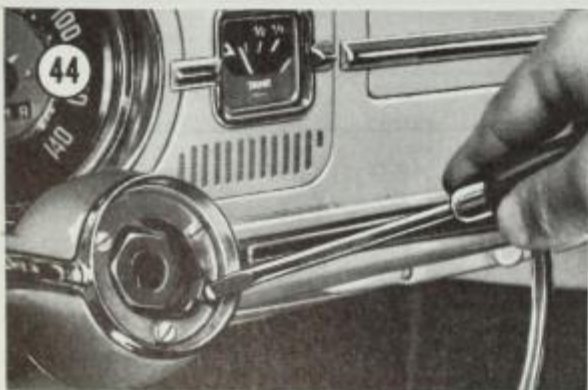
CAUTION: *Never substitute tinfoil or wire for a fuse. An overload could result in fire and complete loss of the automobile.*

HORN

If the horn works, but not loudly nor not at the correct pitch, make sure it is not touching the body. Horn pitch and loudness can be adjusted by removing the seal on the rear of the horn and turning the adjusting screw underneath.

When the horn does not work at all, check the wiring to the horn and check the horn switch. To service the horn switch:

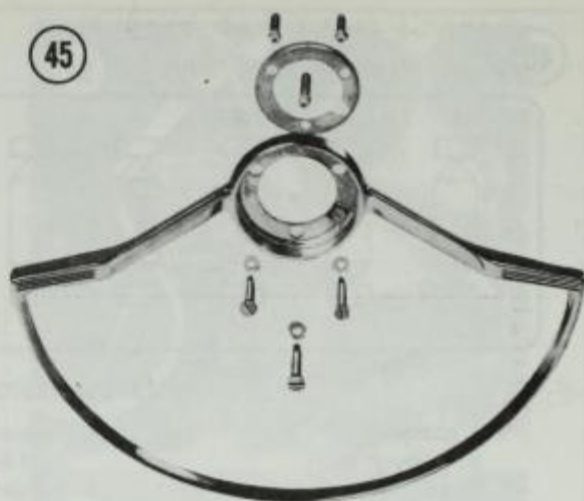
1. Disconnect the battery ground cable.
2. Carefully pry the horn ring cap off with a screwdriver.
3. Disconnect the cable (see **Figure 44**).



4. Remove 3 screws securing the horn ring and remove it.
5. Inspect the 3 contact pins, and replace any that are badly burned (see **Figure 45**). Others may be cleaned with fine crocus cloth.
6. Installation is the reverse of these steps.

Horn Replacement

1a. On Beetles, the horn is located under the left front fender. Remove the bolt securing the horn to its bracket.

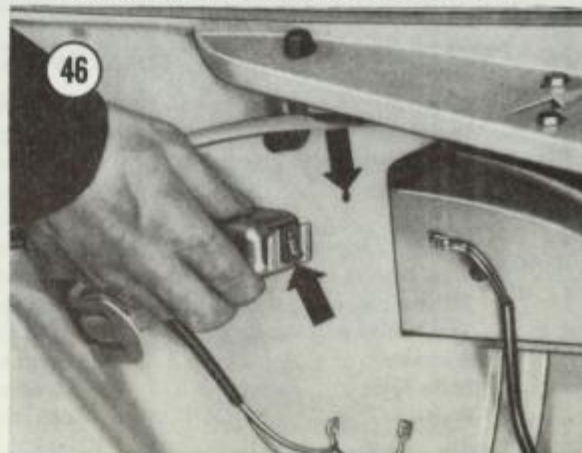


1b. On Karmann Ghias, dual horns are located in the spare wheel compartment. Loosen rubber boot in front panel. Remove bolts securing horns.

2. Disconnect wire(s) from horn(s).
3. Remove the horn(s). On Karmann Ghias, remove defective horn from rubber boot after removing horns.
4. Installation is the reverse of these steps. Make sure that the horns do not touch the car body.

Horn Relay Replacement (Karmann Ghia Only)

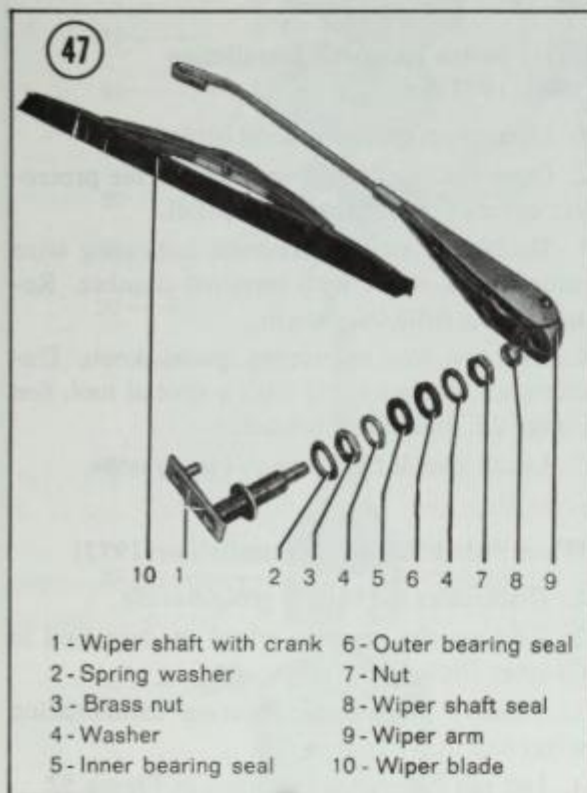
1. Remove horn fuse from fuse box. See Figures 39-41 for location.
2. Disconnect wires from relay. Make a wiring sketch to simplify installation.
3. Pull the relay out of the side panel hole. See **Figure 46**.
4. Installation is the reverse of these steps.



WINDSHIELD WIPER SYSTEM

Wiper Frame Removal/Installation

1. Disconnect battery ground cable.
2. Loosen clamp screws on wiper arms and remove the wiper arm and blade assembly.
3. Remove both wiper shaft seals, nuts, washers, and outer bearing seals. See **Figure 47**.



4. Open front hood and remove protective cover over instrument panel.

5. Disconnect and mark wires from 1961-1971 wiper motors. On 1972 motors, disconnect the motor connector.

6. Remove glove box.

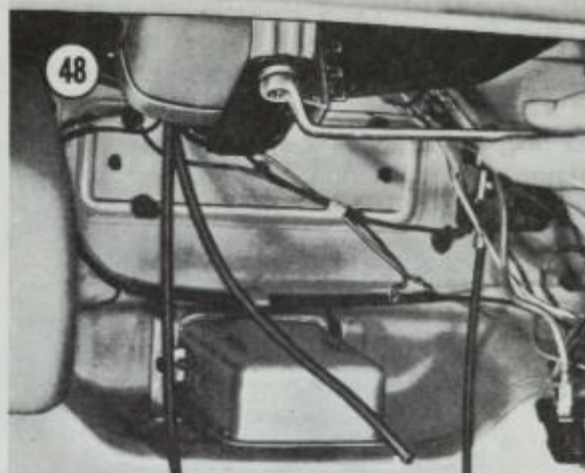
7. Remove bolt securing wiper frame to body. See **Figure 48**.

8. Remove frame complete with motor and linkage.

9. Installation is the reverse of these steps. Lubricate all bearing surfaces with oil.

Frame Bearing Replacement

1. Remove wiper frame with motor as described earlier.
2. Unhook spring between frame and connecting rod.



3. Disconnect connecting rod and drive link from wiper shaft cranks.

4. Remove inner seal and washer.

5. Remove brass retaining nut and remove wiper bearing.

6. Install new bearing with lug on frame in bearing groove. Secure with brass retaining nut. Install washer and inner seal (shoulder away from frame).

7. Check plastic bushings in connecting rod and drive link. Replace rod or link if bushings are worn.

8. Install connecting rod and drive link with hollow side towards frame. Note that angled end of drive link is towards the right hand bearing.

9. Install wiper frame and motor as described earlier.

Wiper Motor Removal/Installation

1. Remove wiper frame and motor as described previously.

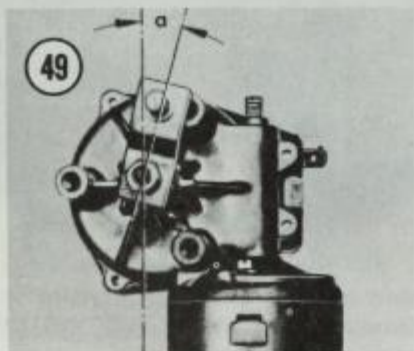
2. Remove lock washer and spring washer from motor drive shaft crank and disconnect drive link.

3a. On 1961-69 systems, loosen the wiper shaft securing nut. Remove nut securing motor to frame and remove the motor.

3b. On 1970-1972 systems, remove 3 screws securing the motor to the frame and remove the motor.

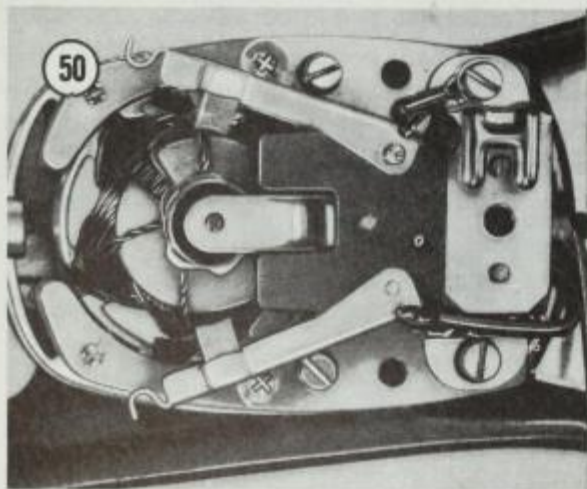
4a. On 1961-69 systems, installation is the reverse of these steps.

4b. On 1970-1972 systems, temporarily connect the wiper motor to the wiper switch. Run the motor a few minutes, and check that it stops at its park position. The crank should be at a 15° angle from the pole housing centerline. See **Figure 49**. Installation is the reverse of these steps.



Brush Replacement (1961-1969)

1. Remove the motor as described previously.
2. Remove motor cover.
3. Remove brush holder spring and swing holders outward. See **Figure 50**.



4. Pull brushes out with long nose pliers and insert new ones.
5. Clean and examine the commutator for excessive wear or burns.
6. Install brush holder spring.
7. Install motor cover and install motor and frame.

Brush Replacement (1970-1972)

Refer to **Figure 51** for the following procedure.

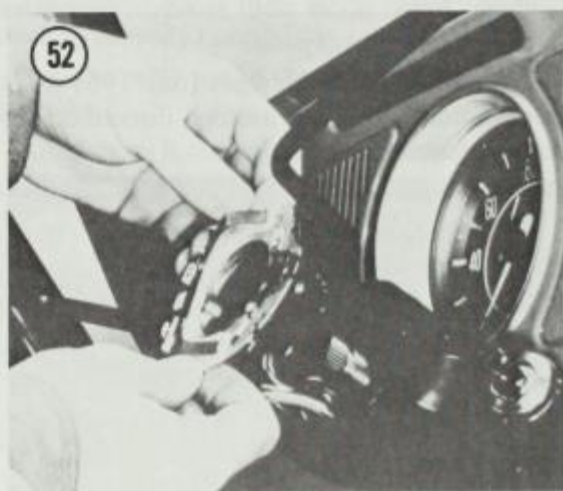
1. Remove motor as described earlier.
2. Remove screws securing pole housing to gear assembly. Remove housing.
3. Remove 3 brushes and replace them.
4. Clean and examine commutator for excessive wear and burns.
5. Reassemble by reversing these steps.

Wiper Switch Removal/Installation (1961-1971)

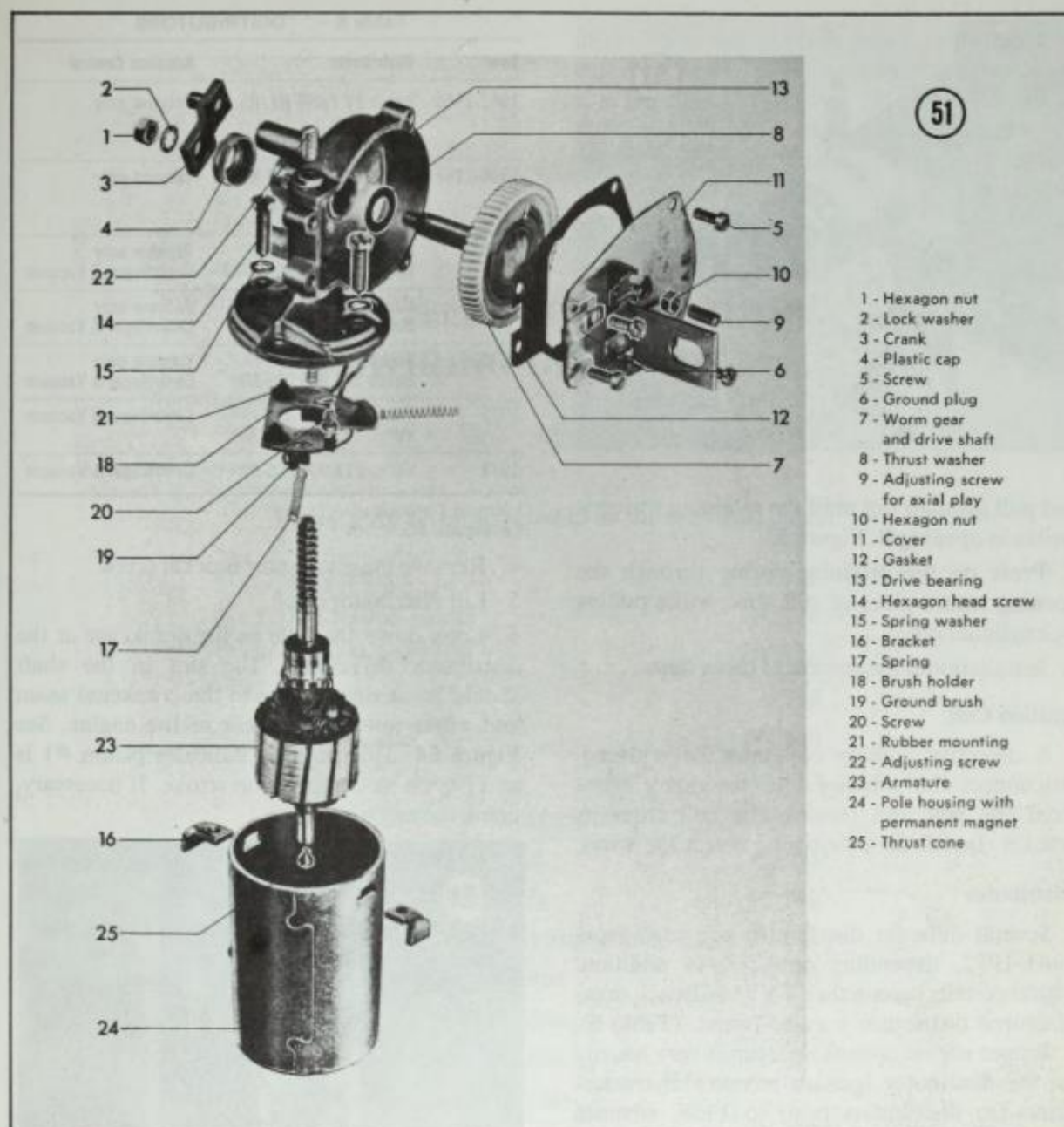
1. Disconnect battery ground cable.
2. Open the front hood and remove the protective cover over the instrument panel.
3. Sketch the switch terminals indicating wire color. Mark wires with terminal number. Remove wires from the switch.
4. Unscrew the instrument panel knob. Unscrew the retaining ring with a special tool. See **Figure 25**. Pull the switch out.
5. Installation is the reverse of these steps.

Wiper Switch Removal/Installation (1972)

1. Disconnect the battery ground cable.
2. Remove the steering wheel as described in Chapter Eleven.
3. Remove 4 screws securing combination wiper and turn signal switch.
4. Lift the switch out as shown in **Figure 52**.



5. Disconnect the electrical connections and washer hose.
6. Installation is the reverse of these steps.



IGNITION SYSTEM

The ignition system consists of the battery, ignition switch, ignition coil, distributor, spark plugs, and associated wiring. The following procedures describe replacement procedures. No ignition components except the distributor are repairable.

Ignition Switch Replacement (1961-1967)

1. Disconnect negative cable at battery.
2. Open the front hood and remove the protective cover for the instrument panel.

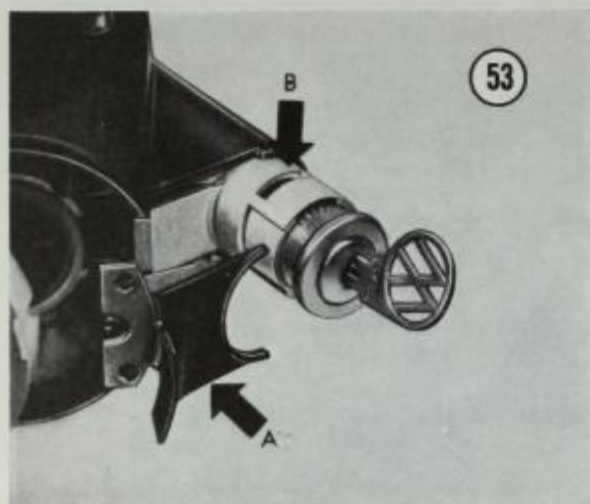
3. Disconnect wires on the ignition switch terminals.

4. Remove screw securing switch bracket and remove the switch.

5. Installation is the reverse of these steps.

Ignition Switch Replacement (1968-1972)

1. Remove the steering wheel as described in Chapter Eleven, Front Suspension and Steering.
2. Loosen turn signal switch and remove 2 screws securing retaining plate A, **Figure 53**.
3. Insert key into lock cylinder, turn key slightly



and pull cylinder out until the retaining spring is visible in opening B, Figure 53.

4. Press on the retaining spring through the opening with a piece of stiff wire, while pulling lock cylinder out.

5. Installation is the reverse of these steps.

Ignition Coil

A defective ignition coil must be replaced. Disconnect the primary and secondary wires from the coil and remove the coil from its bracket. Install the new coil; connect the wires.

Distributor

Several different distributors are used from 1961-1972, depending on year. In addition, within certain years either a VW or Bosch manufactured distributor may be found. (Table 6).

Proper engine operation depends very heavily on the distributor ignition advance characteristics. On distributors prior to 1968, advance was controlled solely by engine vacuum. Later distributors employ centrifugal and vacuum advance. Adjustment of the advance mechanism is critical and requires special test fixtures. Take the job to your dealer or a competent ignition specialist.

To remove the distributor:

1. Release hold-down clamps for the distributor cap and lift it off.
2. Disconnect the primary lead from ignition coil terminal 1.
3. Disconnect the vacuum line to the vacuum advance unit.

Table 6 DISTRIBUTORS

Year	Distributor	Advance Control
1961-1965	Bosch ZV PAU4 R2/R5 or VW 113 905 205 B	Vacuum only
1966-1967	Bosch 113 905 205 K or VW 113 905 205 L	Vacuum only
1968	Bosch 113 905 205 M ¹ Bosch 113 905 205 P/AA ²	Vacuum only Centrifugal & Vacuum
1969	Bosch 113 905 205 M/T ¹ Bosch 113 905 205 AA ²	Vacuum only Centrifugal & Vacuum
1970	Bosch 113 905 205 T ¹ Bosch 113 905 205 AD ²	Vacuum only Centrifugal & Vacuum
1971	VW 113 905 205 AJ ¹ VW 113 905 205 AK ²	Centrifugal & Vacuum
1972	VW 113 905 205 AN ^{1 2}	Centrifugal & Vacuum

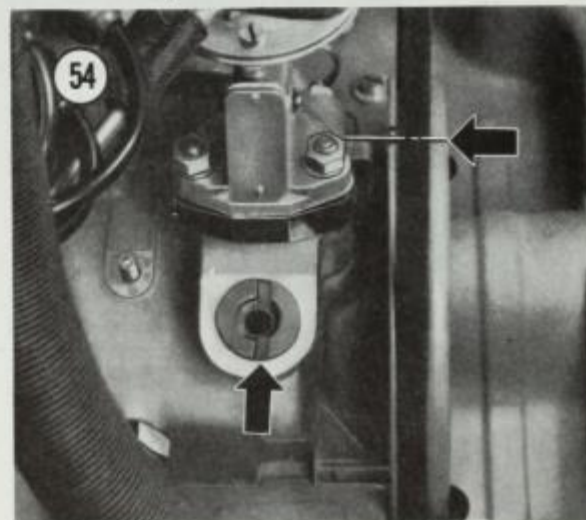
¹ Manual Transaxle

² Automatic Stick Shift

4. Remove the distributor bracket screw.

5. Lift distributor out.

6. Look down the hole in the crankcase at the distributor driveshaft. The slot in the shaft should be at right angles to the crankcase seam and offset towards the rear of the engine. See Figure 54. This position indicates piston #1 is at TDC on its compression stroke. If necessary, crank the engine over.



7. Insert the distributor shaft in the hole and turn rotor until it points to the notch on the distributor housing. Ensure that the distributor shaft properly engages in the drive shaft slot.

8. Secure the distributor bracket with a screw.

9. Install the distributor cap and set ignition timing (see Chapter Two).

WIRING DIAGRAMS

Wiring diagrams will be found on the following pages:

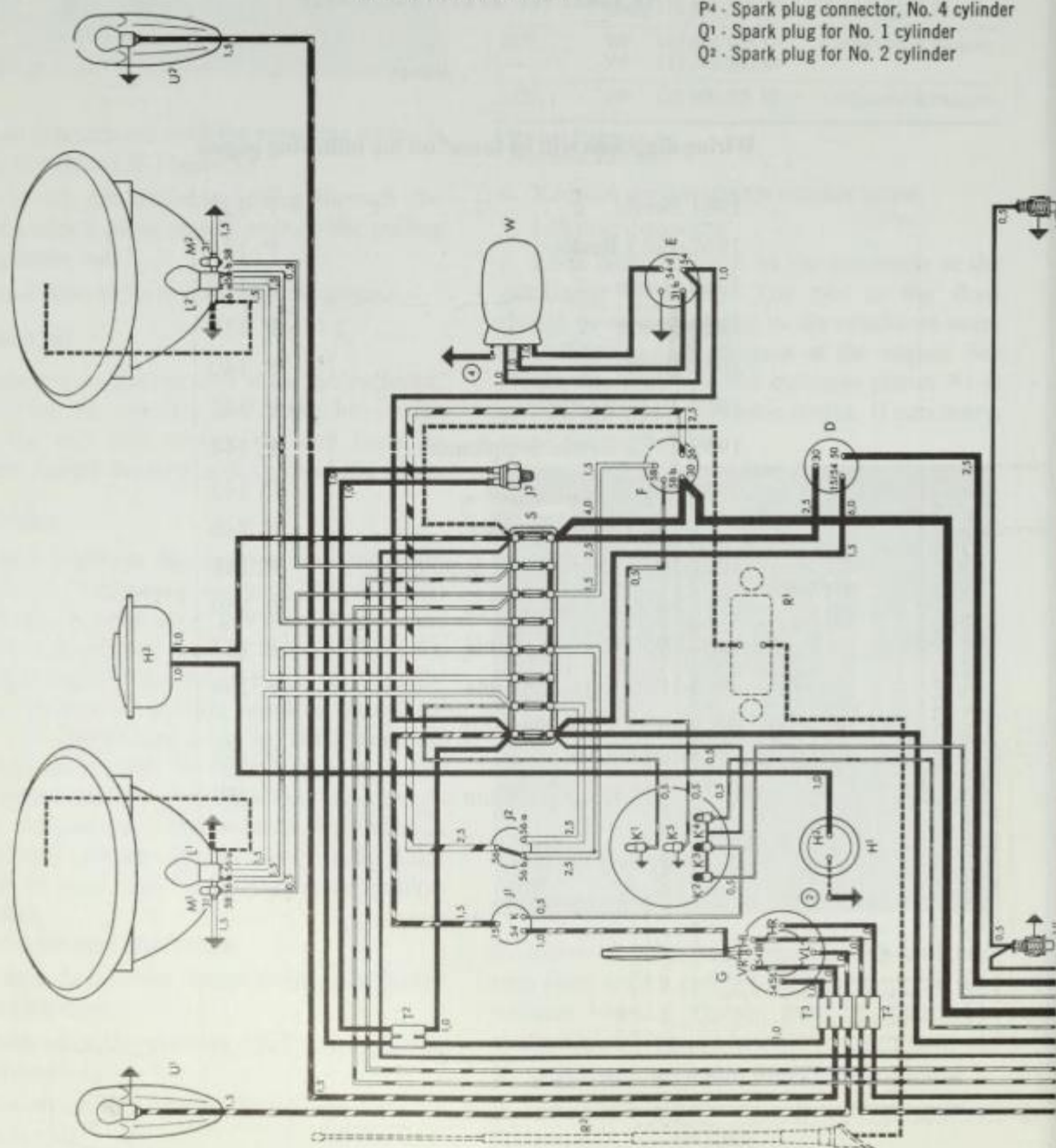
1961 Beetle	P. 132
1962-1965 Beetle	P. 134
1966 Beetle	P. 136
1967 Beetle	P. 138
1968 Beetle	P. 140
1969-1972 Beetle	P. 142
1969-1972 Beetle Supplement	P. 144
Notes on 1972 Changes	P. 145
1971-1972 Super Beetle	P. 146
1971-1972 Super Beetle Supplement	P. 148
1961-1966 Karmann Ghia	P. 150
1967-1968 Karmann Ghia	P. 152
1969-1970 Karmann Ghia	P. 154
1969-1972 Karmann Ghia Supplement	P. 156
1971-1972 Karmann Ghia	P. 158

WIRING DIAGRAM — 1961 BEETLE

- A - Battery
- B - Starting motor
- C - Generator
- D - Ignition/starter switch
- E - Windshield wiper switch
- F - Light switch and instrument panel lighting
- G - Flashing indicator switch (self-cancelling)
- H¹ - Horn half ring
- H² - Steering column connection

- H³ - Horn
- J¹ - Flasher relay
- J² - Dimmer switch
- J³ - Stop light switch
- J⁴ - Oil pressure switch
- K¹ - High beam indicator light
- K² - Generator control light
- K³ - Flashing indicator control light
- K⁴ - Oil pressure warning light
- K⁵ - Speedometer light
- L¹ - Bifilament bulb for headlight, left or sealed-beam insert, left

- L² - Bifilament bulb for headlight, right or sealed-beam insert, right
- M¹ - Parking light, left
- M² - Parking light, right
- M³ - Parking light, sealed-beam insert, left
- M⁴ - Parking light, sealed-beam insert, right
- N - Ignition distributor
- O - Ignition coil
- O¹ - Automatic choke on carburetor
- P¹ - Spark plug connector, No. 1 cylinder
- P² - Spark plug connector, No. 2 cylinder
- P³ - Spark plug connector, No. 3 cylinder
- P⁴ - Spark plug connector, No. 4 cylinder
- Q¹ - Spark plug for No. 1 cylinder
- Q² - Spark plug for No. 2 cylinder



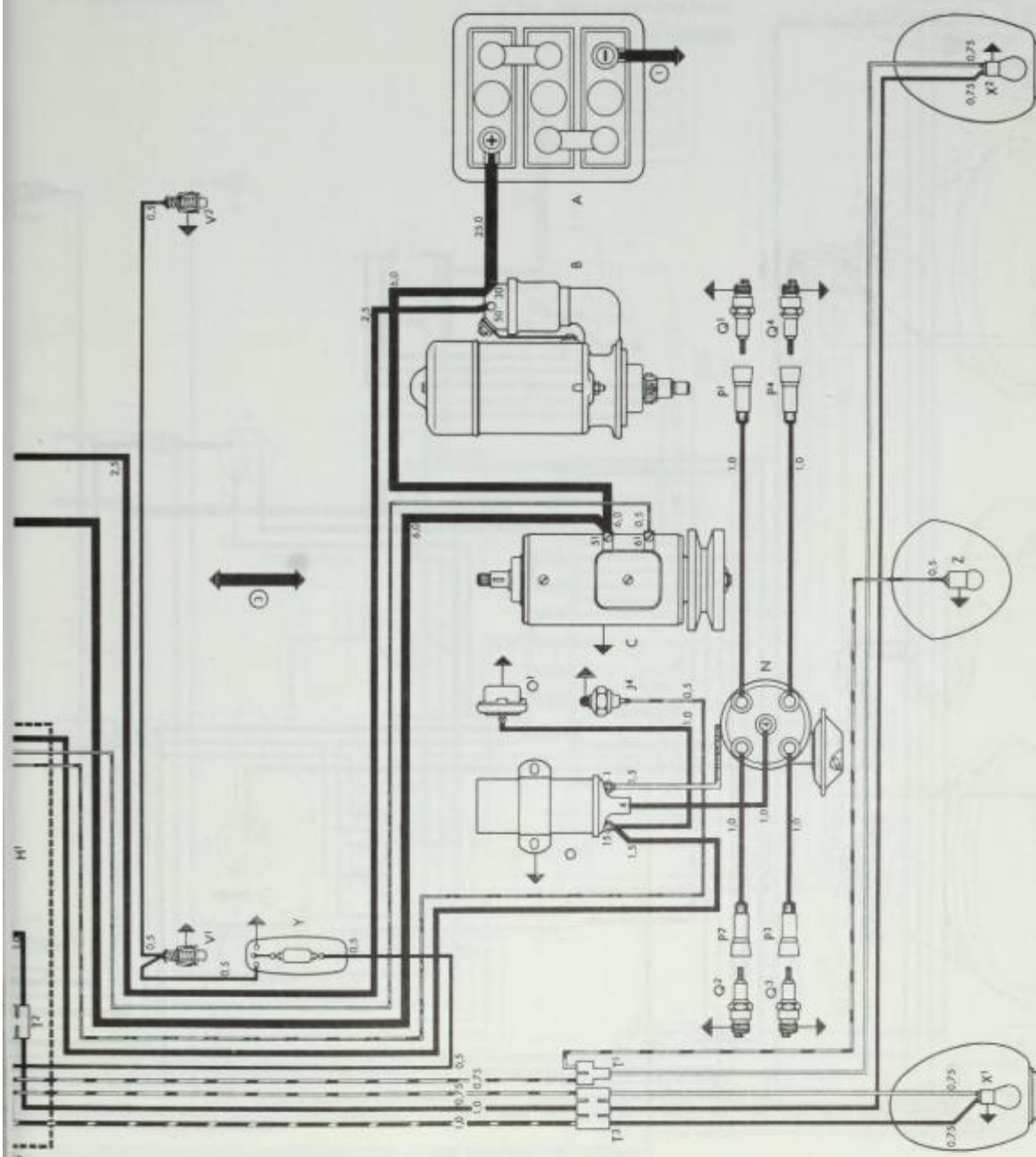
Q³ - Spark plug for No. 3 cylinder
 Q⁴ - Spark plug for No. 4 cylinder
 R¹ - Radio
 R² - Antenna
 S - Fuse box (eight fuses)
 T¹ - Connector
 T² - Connector, double
 T³ - Connector, triple

U¹ - Flasher light, left
 U² - Flasher light, right
 V¹ - Door contact switch, left
 V² - Door contact switch, right
 V³ - Roof switch, convertible
 W - Windshield wiper motor
 (3 connections)
 X¹ - Indicator, stop and tail light, left
 X² - Indicator, stop and tail light, right
 Y - Interior light

Z - License plate light

- ① - Battery ground strap
- ② - Steering column flange ground strap
- ③ - Ground strap between transmission and frame
- ④ - Ground strap between windshield wiper motor and body

Black dotted line = Service Installation

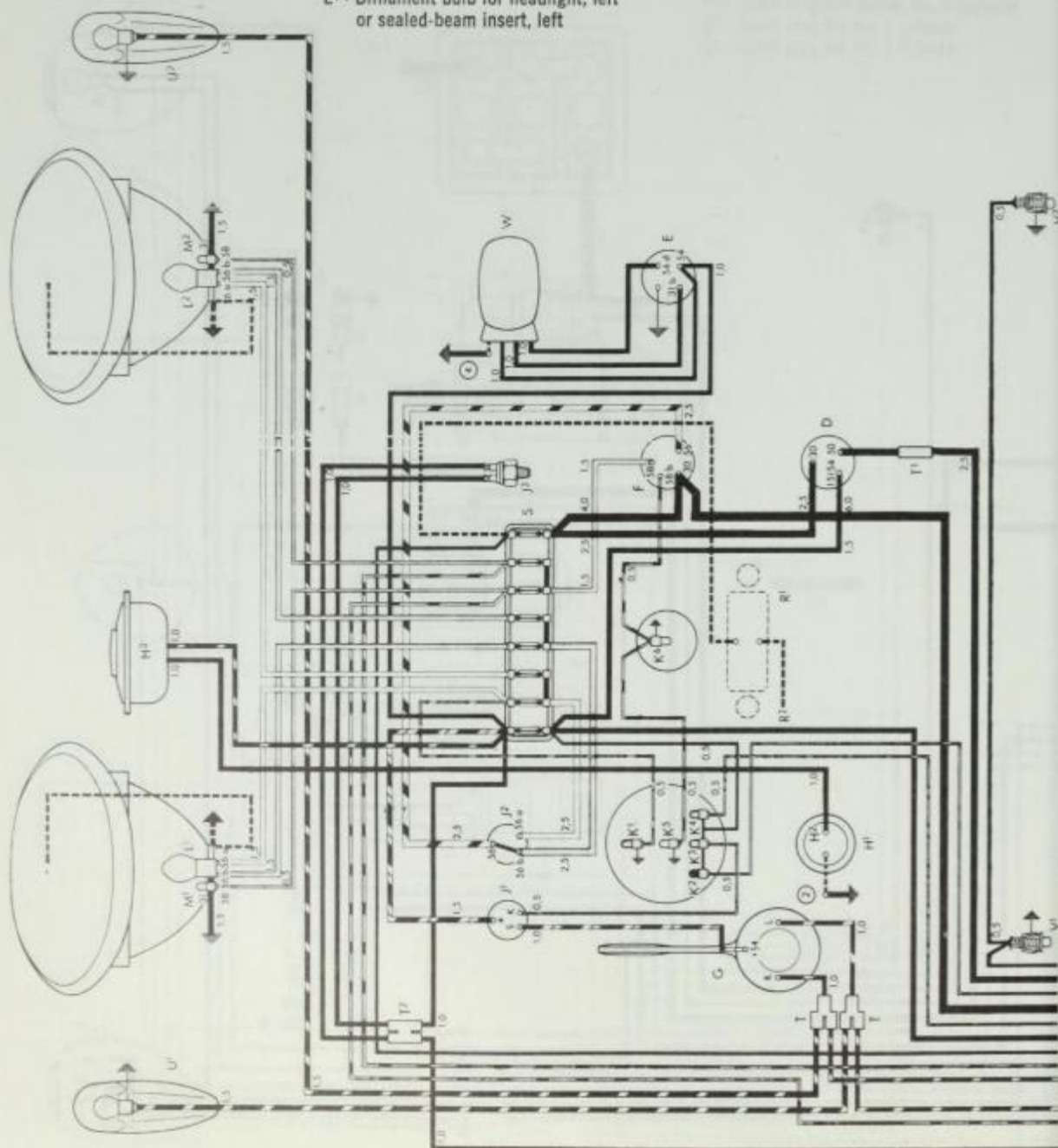


WIRING DIAGRAM — 1962-1965 BEETLE

- A - Battery
- B - Starting motor
- C - Generator
- D - Ignition/starter switch
- E - Windshield wiper switch
- F - Light switch and instrument panel lighting
- G - Flashing indicator switch (self-cancelling)
- H¹ - Horn half ring
- H² - Steering column connection

- H² - Horn
- J¹ - Flasher relay
- J² - Dimmer switch
- J³ - Stop light switch
- J⁴ - Oil pressure switch
- K¹ - High beam indicator light
- K² - Generator control light
- K³ - Flashing indicator control light
- K⁴ - Oil pressure warning light
- K⁵ - Speedometer light
- K⁶ - Fuel gauge light
- L¹ - Bifilament bulb for headlight, left or sealed-beam insert, left

- L² - Bifilament bulb for headlight, right or sealed-beam insert, right
- M¹ - Parking light, left
- M² - Parking light, right
- M³ - Parking light, sealed-beam insert, left
- M⁴ - Parking light, sealed-beam insert, right
- N - Ignition distributor
- O - Ignition coil
- O¹ - Automatic choke on carburetor
- P¹ - Spark plug connector, No. 1 cylinder
- P² - Spark plug connector, No. 2 cylinder



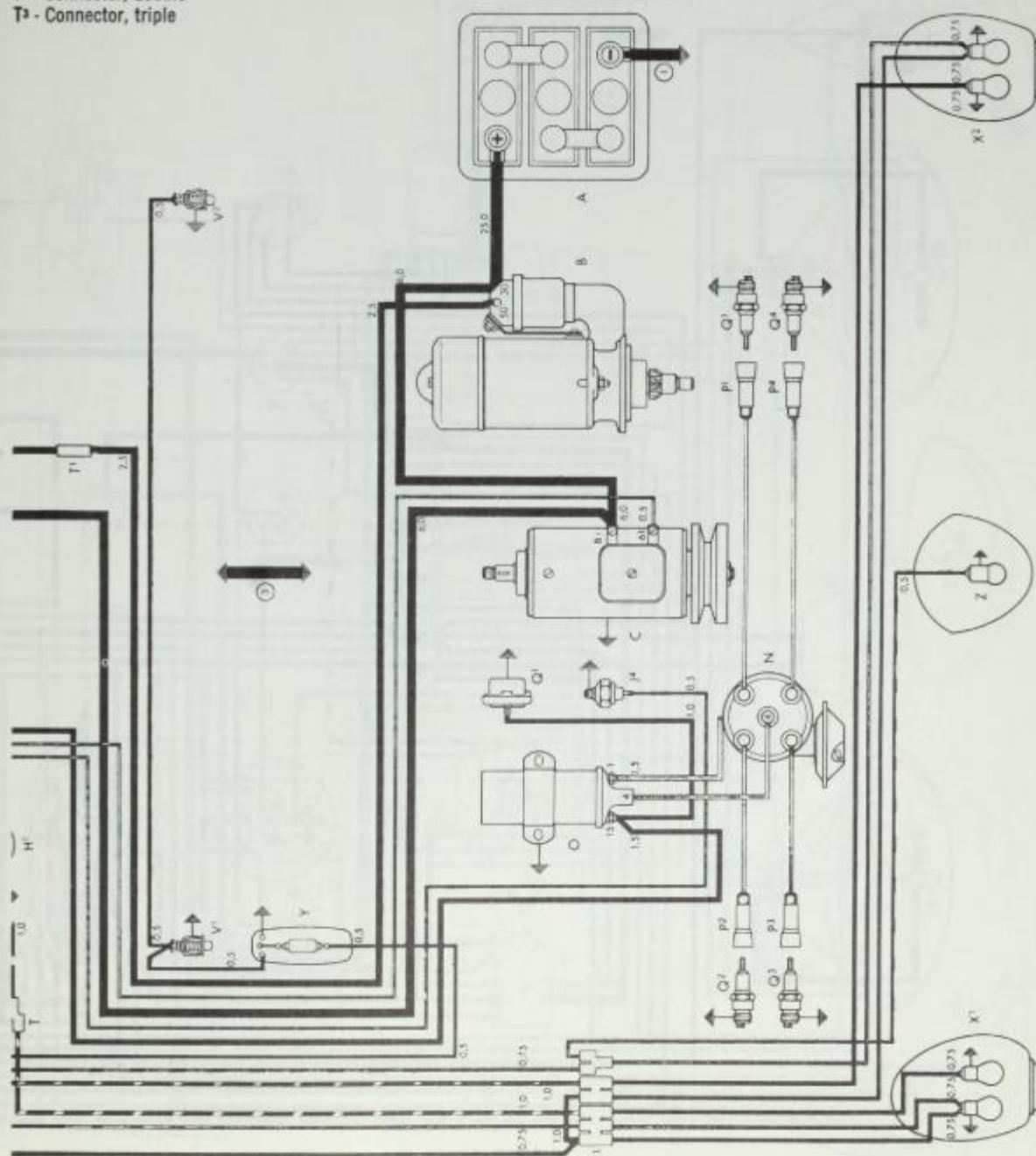
P₃ - Spark plug connector, No. 3 cylinder
 P₄ - Spark plug connector, No. 4 cylinder
 Q₁ - Spark plug for No. 1 cylinder
 Q₂ - Spark plug for No. 2 cylinder
 Q₃ - Spark plug for No. 3 cylinder
 Q₄ - Spark plug for No. 4 cylinder
 R₁ - Radio
 R₂ - Aerial connection
 S - Fuse box (eight fuses)
 T - Cable connector
 T₁ - Connector, single
 T₂ - Connector, double
 T₃ - Connector, triple

U₁ - Flasher light, left
 U₂ - Flasher light, right
 V₁ - Door contact switch, left
 V₂ - Door contact switch, right
 W - Windshield wiper motor
 (3 connections)
 X₁ - Indicator, stop and tail light, left
 X₂ - Indicator, stop and tail light, right
 Y - Interior light

Z - License plate light

- ① - Battery ground strap
- ② - Horn ring to steering column flange ground strap
- ③ - Ground strap between transmission and frame
- ④ - Ground strap between windshield wiper motor and body

Black dotted line = Service Installation

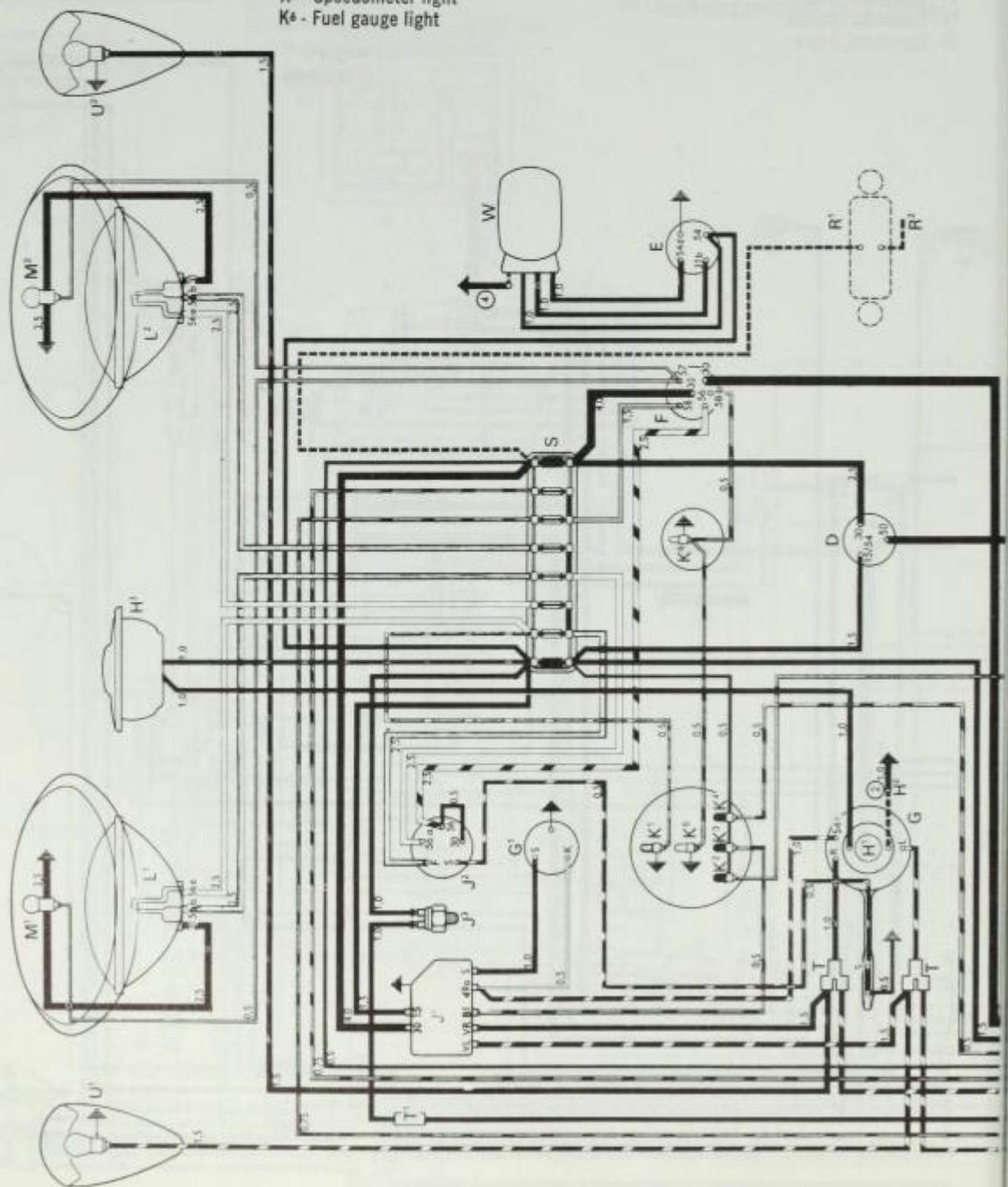


WIRING DIAGRAM — 1966 BEETLE

A - Battery
B - Starter
C - Generator
D - Ignition/starter switch
E - Windshield wiper switch
F - Lighting switch
G - Turn signal switch with dimmer switch
G¹ - Emergency light switch
H¹ - Horn half ring

H² - Steering column connection
H³ - Horn
J¹ - Flasher and emergency light relay
J² - Dimmer relay
J³ - Brake light switch
J⁴ - Oil pressure switch
K¹ - High beam warning light
K² - Generator warning light
K³ - Turn signal warning light
K⁴ - Oil pressure warning light
K⁵ - Speedometer light
K⁶ - Fuel gauge light

L¹ - Sealed beam unit, left
L² - Sealed beam unit, right
M¹ - Parking light, left
M² - Parking light, right
N - Distributor
O - Ignition coil
O¹ - Automatic choke
O² - Electro-magnetic pilot jet
P¹ - Spark plug connector, No. 1 cylinder
P² - Spark plug connector, No. 2 cylinder



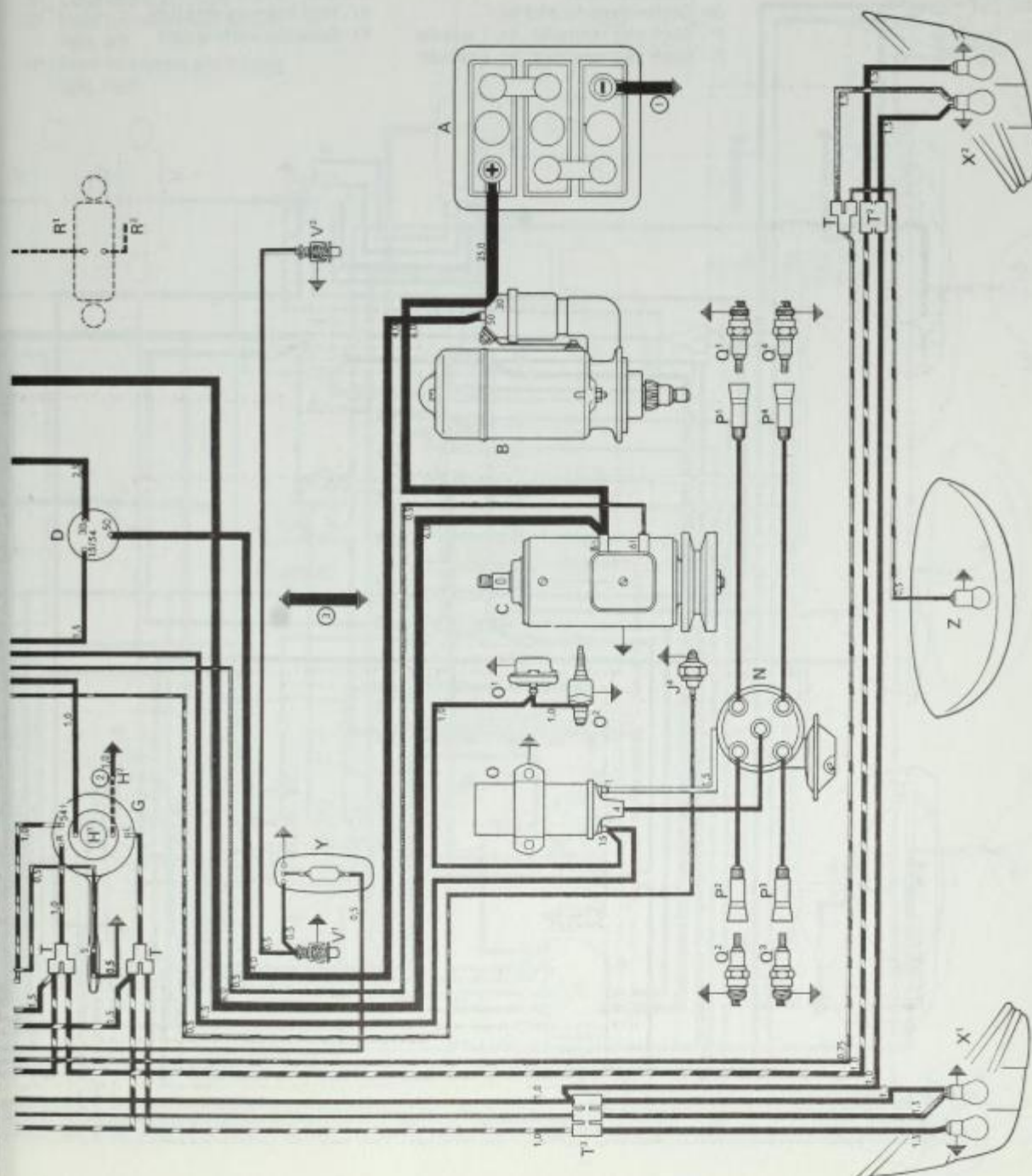
P³ - Spark plug connector, No. 3 cylinder
 P⁴ - Spark plug connector, No. 4 cylinder
 Q¹ - Spark plug for No. 1 cylinder
 Q² - Spark plug for No. 2 cylinder
 Q³ - Spark plug for No. 3 cylinder
 Q⁴ - Spark plug for No. 4 cylinder
 R¹ - Radio
 R² - Antenna connection
 S - Fuse box
 white fuses: 8 ampere
 red fuses: 16 ampere

T¹ - Cable connector, single
 T² - Cable connector, double
 T³ - Cable connector, triple
 U¹ - Turn signal, left
 U² - Turn signal, right
 V¹ - Door switch, left
 V² - Door switch, right
 W - Windshield wiper motor
 X¹ - Brake, turn signal and tail lights, left
 X² - Brake, turn signal and tail lights, right
 Y - Interior light

Z - License plate light

- ① - Battery to frame ground strap
- ② - Horn ring to steering coupling ground connection
- ③ - Transmission to frame ground strap
- ④ - Wiper motor to body ground strap

Black dotted line = Optional extras or service installation

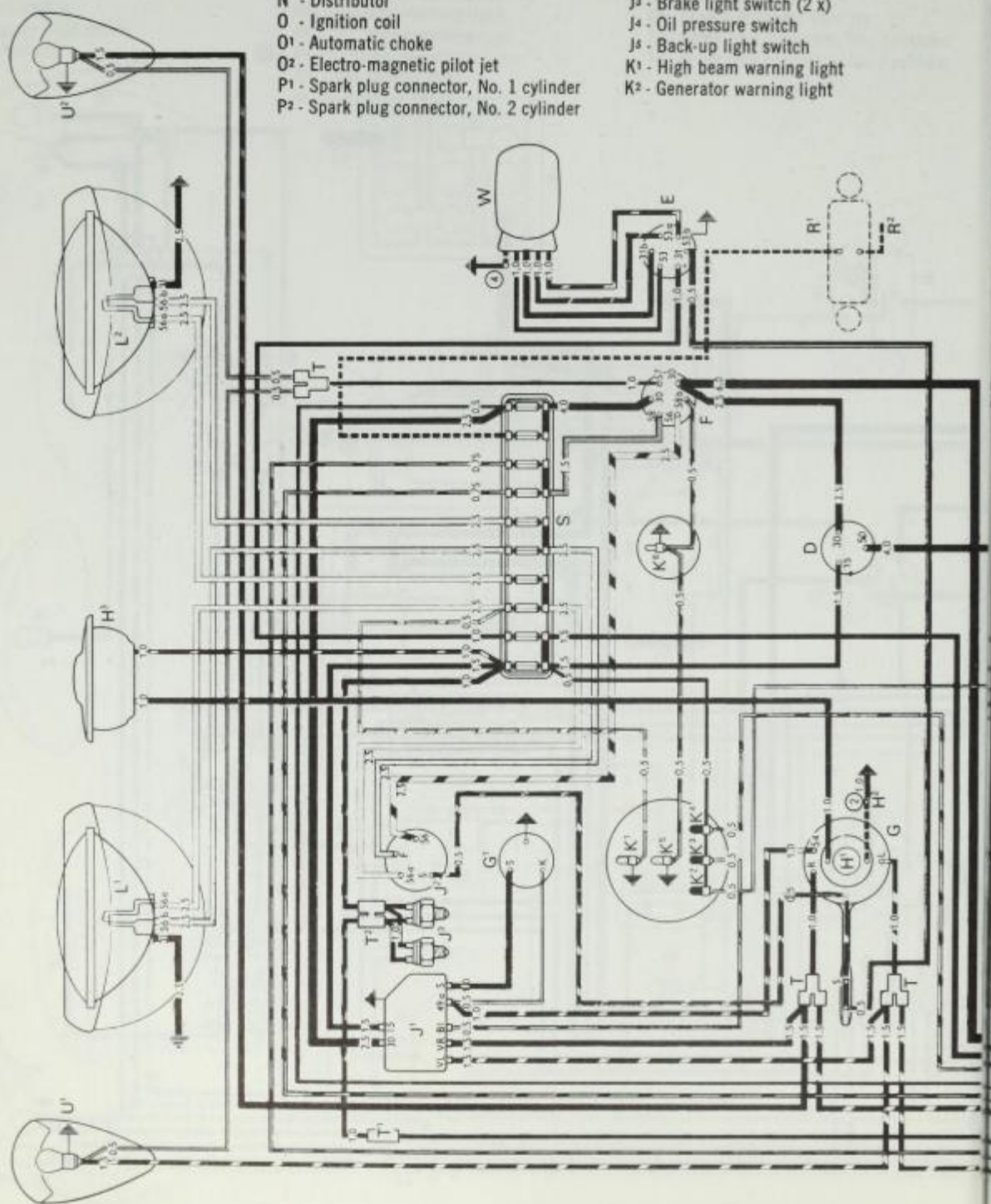


WIRING DIAGRAM — 1967 BEETLE

- A - Battery
- B - Starter
- C - Generator
- C¹ - Regulator
- D - Ignition/starter switch
- E - Windshield wiper switch
- F - Lighting switch

- K³ - Turn signal warning light
- K⁴ - Oil pressure warning light
- K⁵ - Speedometer light
- K⁶ - Fuel gauge light
- L¹ - Sealed beam insert, left
- L² - Sealed beam insert, right
- M¹ - Back-up light, left
- M² - Back-up light, right
- N - Distributor
- O - Ignition coil
- O¹ - Automatic choke
- O² - Electro-magnetic pilot jet
- P¹ - Spark plug connector, No. 1 cylinder
- P² - Spark plug connector, No. 2 cylinder

- G - Turn signal switch with automatic cancelling and hand dimmer button
- G¹ - Emergency light switch
- H¹ - Horn half ring
- H² - Steering column connection
- H³ - Horn
- J¹ - Turn signal and emergency light relay
- J² - Dimmer relay
- J³ - Brake light switch (2 x)
- J⁴ - Oil pressure switch
- J⁵ - Back-up light switch
- K¹ - High beam warning light
- K² - Generator warning light

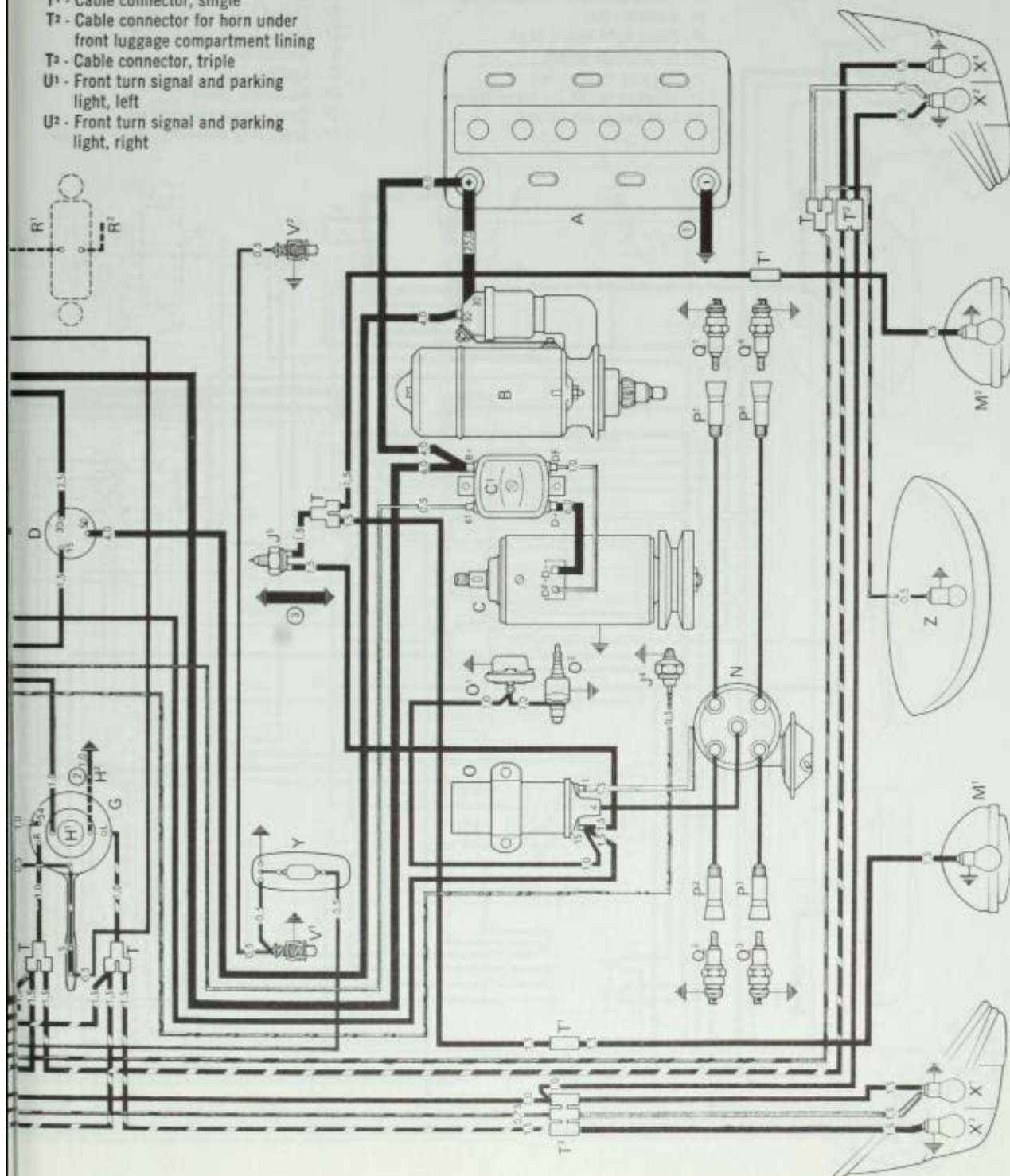


- P² - Spark plug connector, No. 4 cylinder
 P⁴ - Spark plug connector, No. 3 cylinder
 Q¹ - Spark plug for No. 1 cylinder
 Q² - Spark plug for No. 2 cylinder
 Q³ - Spark plug for No. 4 cylinder
 Q⁴ - Spark plug for No. 3 cylinder
 R¹ - Radio
 R² - Antenna connection
 S - Fuse box
 T - Cable adaptor
 T¹ - Cable connector, single
 T² - Cable connector for horn under front luggage compartment lining
 T³ - Cable connector, triple
 U¹ - Front turn signal and parking light, left
 U² - Front turn signal and parking light, right

- V¹ - Door contact switch, left
 V² - Door contact switch, right
 W - Windshield wiper motor
 X¹ - Brake and tail light, left
 X² - Brake and tail light, right
 X³ - Rear turn signal light, left
 X⁴ - Rear turn signal light, right
 Y - Interior light
 Z - License plate light

- ① - Battery to frame ground strap
 ② - Horn ring to steering coupling ground connection
 ③ - Transmission to frame ground strap
 ④ - Wiper motor to body ground strap

Black dotted line = Optional extras or service installation

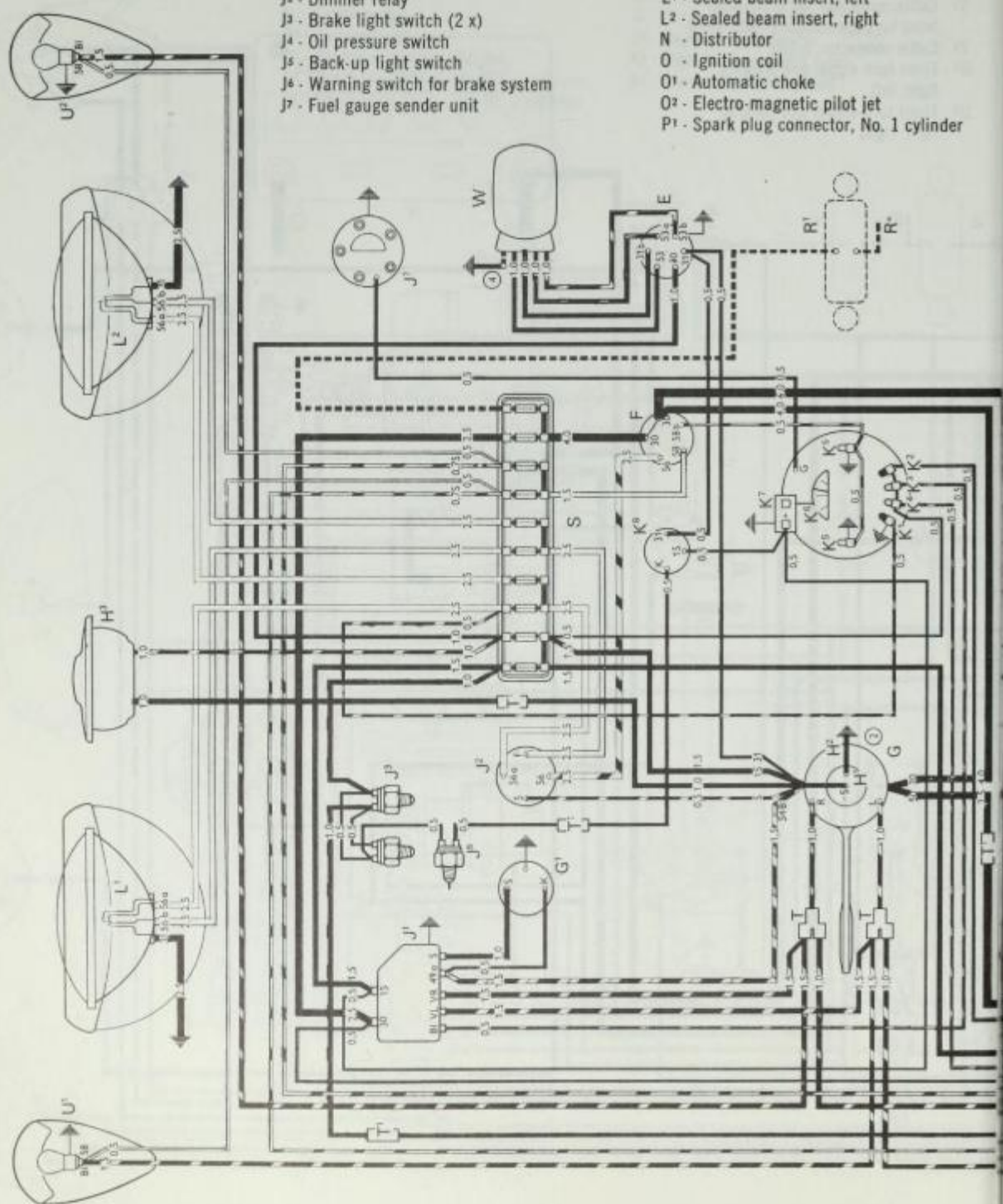


WIRING DIAGRAM — 1968 BEETLE

- A - Battery
B - Starter
C - Generator
C¹ - Regulator
E - Windshield wiper switch
F - Lighting switch

- G - Turn signal switch with automatic cancelling, hand dimmer and ignition/starter switch
G¹ - Emergency light switch
H¹ - Horn half ring
H² - Steering column connection
H³ - Horn
J¹ - Turn signal and emergency light relay
J² - Dimmer relay
J³ - Brake light switch (2 x)
J⁴ - Oil pressure switch
J⁵ - Back-up light switch
J⁶ - Warning switch for brake system
J⁷ - Fuel gauge sender unit

- K¹ - High beam warning light
K² - Generator warning light
K³ - Turn signal warning light
K⁴ - Oil pressure warning light
K⁵ - Speedometer light
K⁶ - Fuel gauge light
K⁷ - Resistance for fuel gauge
K⁸ - Brake warning lamp with test button
L¹ - Sealed beam insert, left
L² - Sealed beam insert, right
N - Distributor
O - Ignition coil
O¹ - Automatic choke
O² - Electro-magnetic pilot jet
P¹ - Spark plug connector, No. 1 cylinder

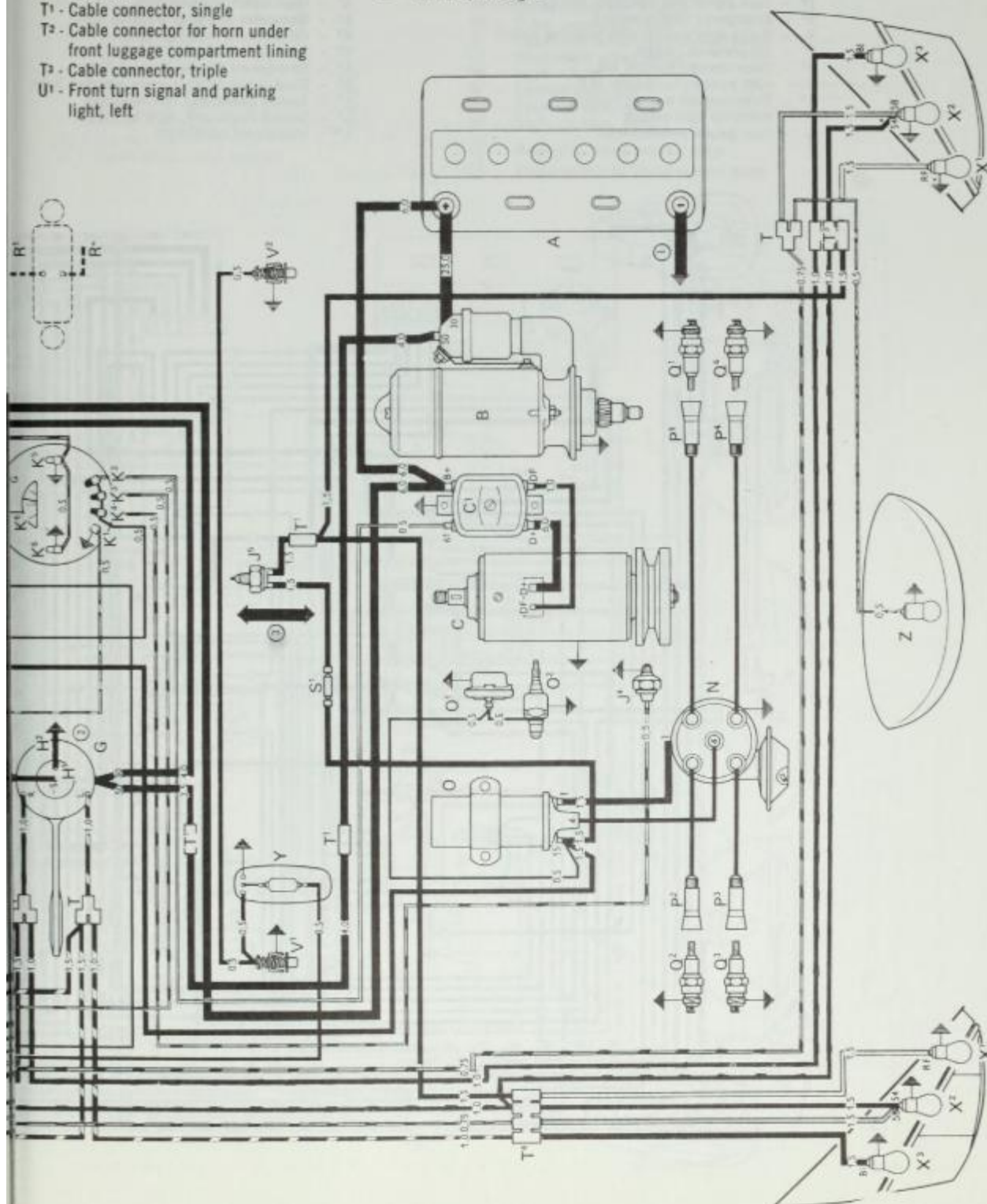


P² - Spark plug connector, No. 2 cylinder
 P³ - Spark plug connector, No. 4 cylinder
 P⁴ - Spark plug connector, No. 3 cylinder
 Q¹ - Spark plug for No. 1 cylinder
 Q² - Spark plug for No. 2 cylinder
 Q³ - Spark plug for No. 4 cylinder
 Q⁴ - Spark plug for No. 3 cylinder
 R¹ - Radio
 R² - Antenna connection
 S - Fuse box
 T¹ - Cable connector, single
 T² - Cable connector for horn under front luggage compartment lining
 T³ - Cable connector, triple
 U¹ - Front turn signal and parking light, left

U² - Front turn signal and parking light, right
 V¹ - Door contact switch, left
 V² - Door contact switch, right
 W - Windshield wiper motor
 X¹ - Back-up lights
 X² - Brake and tail lights
 X³ - Turn signal lights
 Y - Interior light
 Z - License plate light

- ① - Battery to frame ground strap
- ② - Horn ring to steering coupling ground connection
- ③ - Transmission to frame ground strap
- ④ - Wiper motor to body ground strap

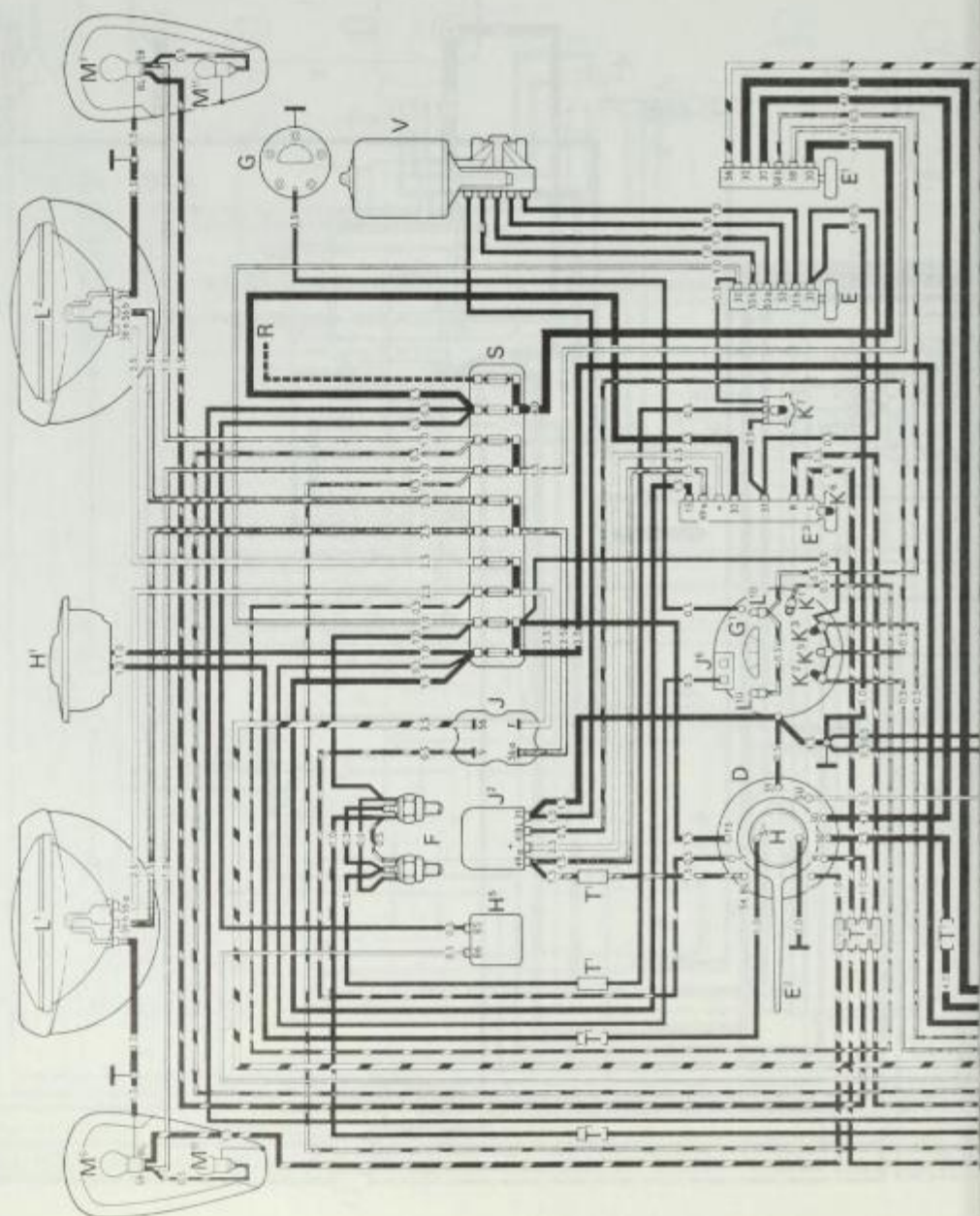
Black dotted line = Optional extras or service installation



WIRING DIAGRAM—1969-1972 BEETLE

- A - Battery
- B - Starter
- C - Generator
- C¹ - Regulator
- D - Ignition/starter switch
- E - Windshield wiper switch
- E¹ - Light switch
- E² - Turn signal and headlight dimmer switch
- E³ - Emergency flasher switch
- F - Brake light switch with warning switch
- F¹ - Oil pressure switch
- F² - Door contact switch, left, with contact for buzzer H 5
- F³ - Door contact switch, right
- F⁴ - Back-up light switch
- G - Fuel gauge sending unit

- G¹ - Fuel gauge
- H - Horn button
- H¹ - Horn
- H² - Ignition key warning buzzer
- J - Dimmer relay
- J² - Emergency flasher relay
- J³ - Vibrator for fuel gauge
- K¹ - High beam warning light
- K² - Generator charging warning light
- K³ - Oil pressure warning light
- K⁴ - Turn signal warning light
- K⁵ - Emergency flasher warning light
- K⁷ - Dual circuit brake system warning light
- L¹ - Sealed beam unit, left headlight
- L² - Sealed beam unit, right headlight
- L¹⁰ - Instrument panel light

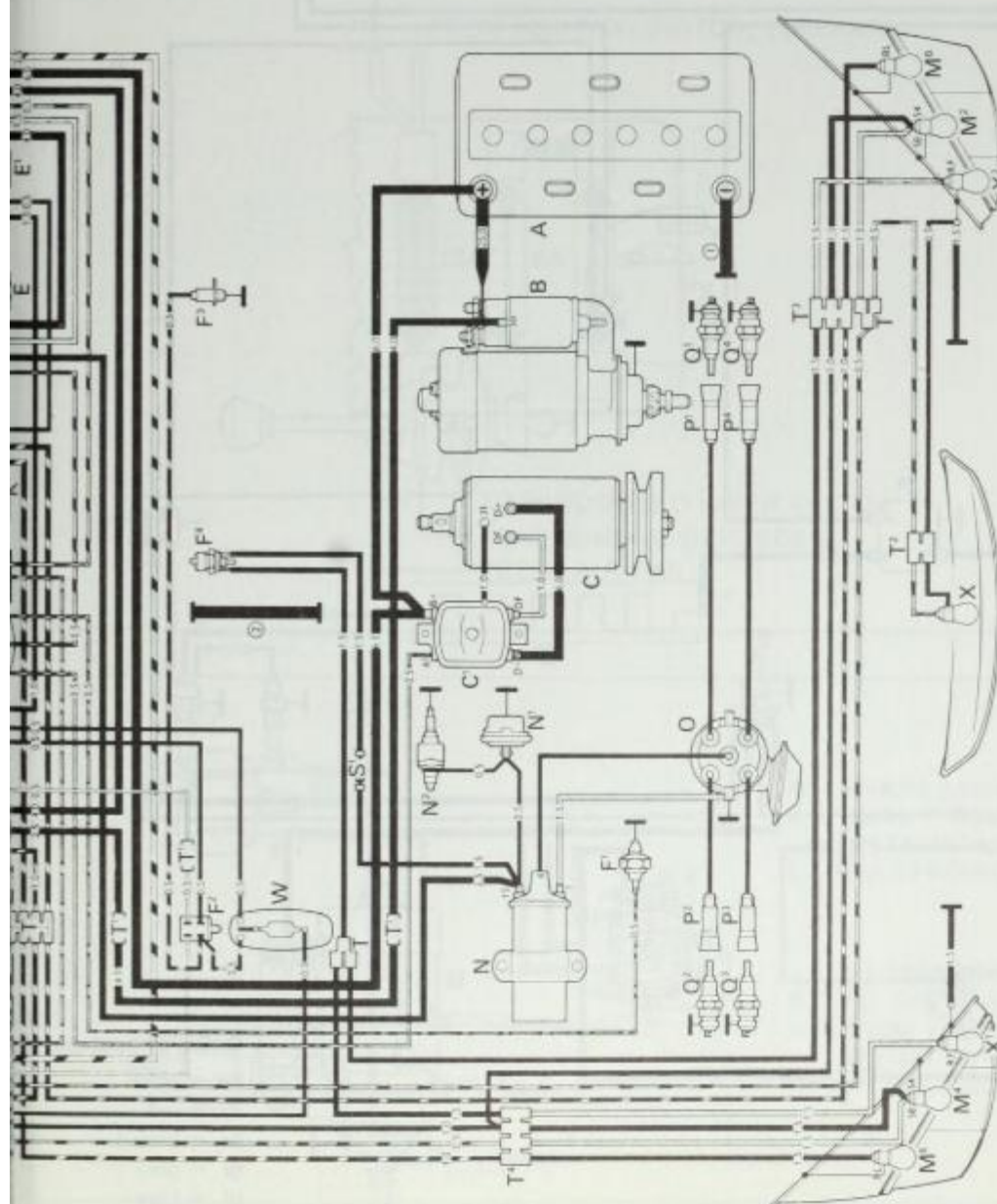


NOTE

For 1972 models, see Page 145.

M² - Tail and brake light, right
 M⁴ - Tail and brake light, left
 M³ - Turn signal and parking light, front, left
 M⁴ - Turn signal, rear, left
 M⁷ - Turn signal and parking light, front, right
 M⁸ - Turn signal, rear, right
 M¹¹ - Side marker light, front
 N - Ignition coil
 N¹ - Automatic choke
 N³ - Electro-magnetic pilot jet
 O - Ignition distributor
 P¹ - Spark plug connector, No. 1 cylinder
 P² - Spark plug connector, No. 2 cylinder
 P³ - Spark plug connector, No. 3 cylinder
 P⁴ - Spark plug connector, No. 4 cylinder
 Q¹ - Spark plug, No. 1 cylinder
 Q² - Spark plug, No. 2 cylinder

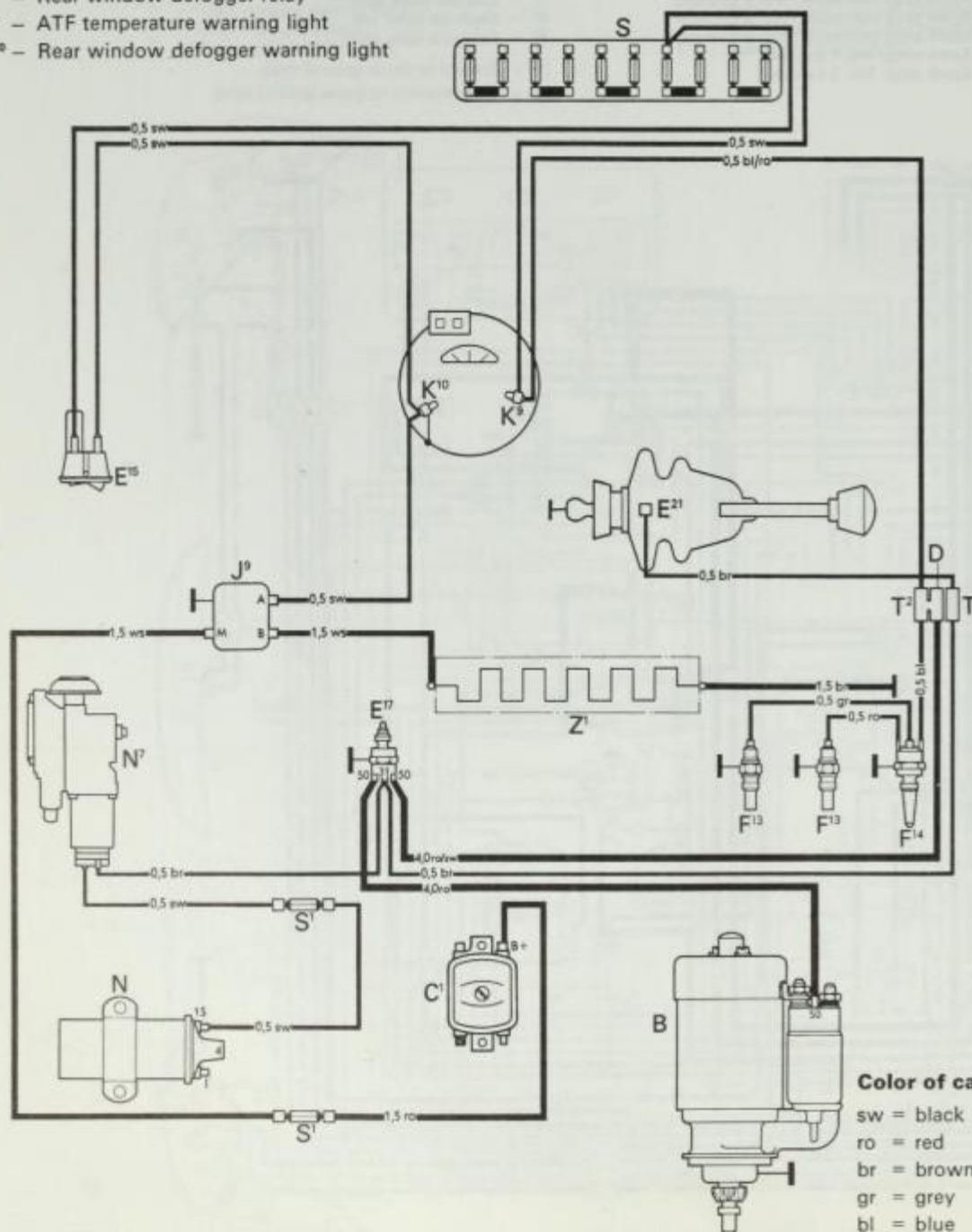
Q³ - Spark plug, No. 3 cylinder
 Q⁴ - Spark plug, No. 4 cylinder
 R - Radio connection
 S - Fuse box
 S¹ - Back-up light fuse
 T - Cable adapter
 T¹ - Cable connector, single
 T² - Cable connector, double
 T³ - Cable connector, triple
 T⁴ - Cable connector (four connections)
 V - Windshield wiper motor
 W - Interior light
 X - License plate light
 X¹ - Back-up light, left
 X² - Back-up light, right
 ① - Battery to frame ground strap
 ② - Transmission to frame ground strap



SUPPLEMENTAL DIAGRAM — 1969-1972 BEETLE (Automatic Stick Shift & Rear Window Defogger)

B — Starter
C¹ — Regulator
D — To ignition/starter switch, terminal 50
E¹⁵ — Switch for rear window defogger
E¹⁷ — Starter cut-out switch
E²¹ — Contact at selector lever
F¹³ — Temperature sensor
F¹⁴ — ATF temperature sensor selector
J⁹ — Rear window defogger relay
K⁹ — ATF temperature warning light
K¹⁰ — Rear window defogger warning light

N — Ignition coil
N⁷ — Automatic Stick Shift control valve
S — Fuse box
S¹ — Fuse for rear window defogger, Automatic Stick Shift control valve
T¹ — Cable connector, single
T² — Cable connector, double
Z¹ — Rear window defogger heating element



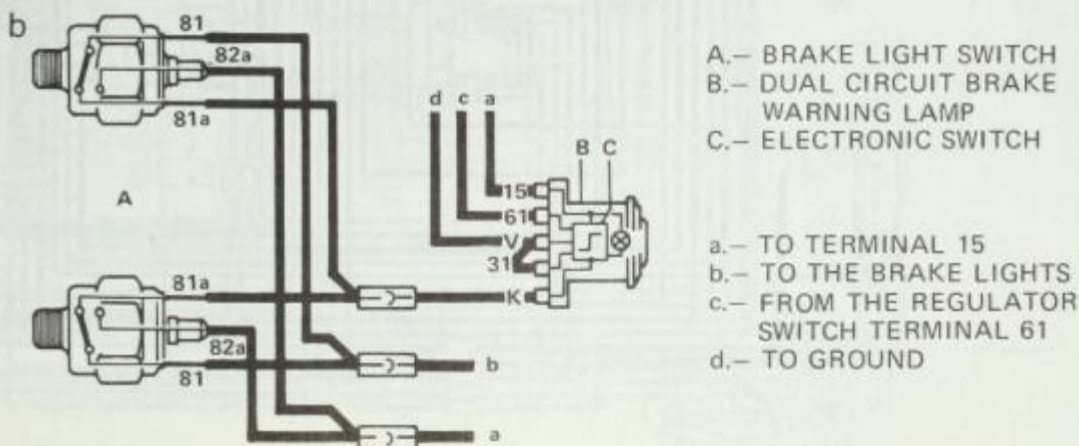
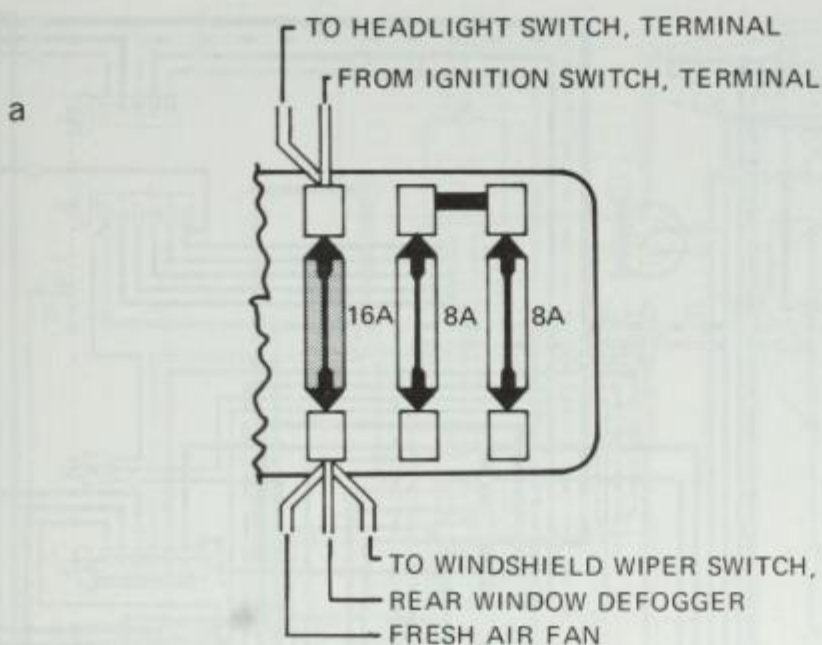
Color of cables :

sw = black
ro = red
br = brown
gr = grey
bl = blue

1972 ELECTRICAL CHANGES

For 1972 Beetles and Karmann Ghias, use the wiring diagrams provided, along with the following changes:

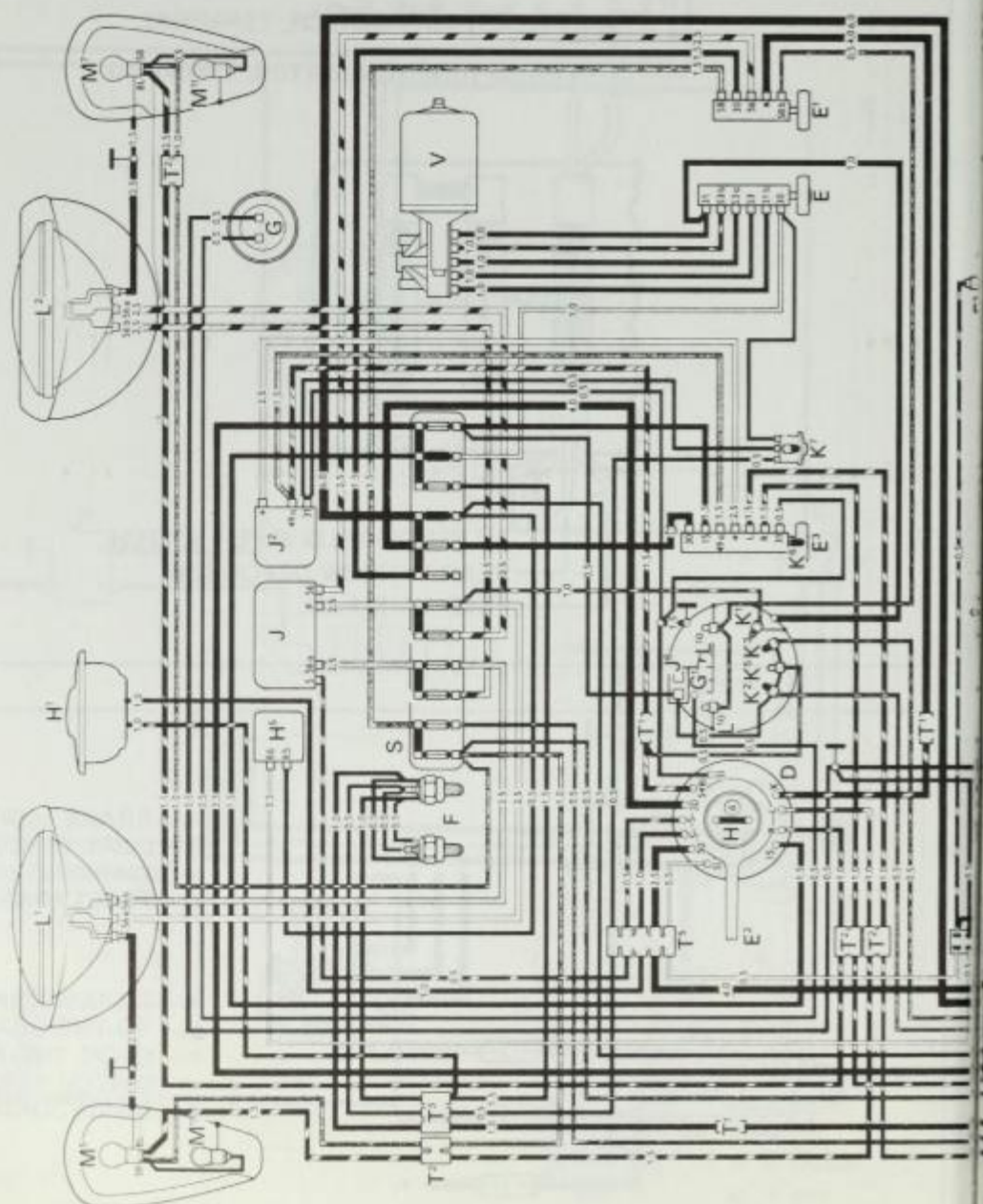
- a. The 3 rightmost fuses are no longer bridged together. The 16 ampere fuse is a separate circuit, wired as shown below. This prevents accessories connected to this fuse from operating unless the ignition switch is on.
- b. A transistorized brake warning circuit replaces the 1971 circuit. The lamp automatically lights when the ignition switch is turned on; on 1971 models, the driver must push the lens to check the lamp. Wiring changes for the 1972 circuit are shown below.



WIRING DIAGRAM — 1971-1972 SUPER BEETLE

- A - Battery
- B - Starter
- C - Generator
- C' - Regulator
- D - Ignition / starter switch
- E - Windshield wiper switch
- E' - Light switch
- E² - Turn signal and headlight dimmer switch
- E³ - Emergency flasher switch
- F - Brake light switch
- F' - Oil pressure switch
- F² - Door contact and buzzer alarm switch, left
- F³ - Door contact switch, right
- F⁴ - Back-up light switch
- G - Fuel gauge sending unit
- G' - Fuel gauge
- H - Horn button

- M¹ - Turn signal and parking light front left
- M² - Turn signal, rear, left
- M³ - Turn signal and parking light front right
- M⁴ - Turn signal, rear, right
- M⁵ - Side marker light, front
- N - Ignition coil
- N' - Automatic choke
- N³ - Electro-magnetic pilot jet
- O - Distributor
- P¹ - Spark plug connector, No. 1 cylinder
- P² - Spark plug connector, No. 2 cylinder
- P³ - Spark plug connector, No. 3 cylinder
- P⁴ - Spark plug connector, No. 4 cylinder
- Q¹ - Spark plug, No. 1 cylinder
- Q² - Spark plug, No. 2 cylinder
- Q³ - Spark plug, No. 3 cylinder
- Q⁴ - Spark plug, No. 4 cylinder

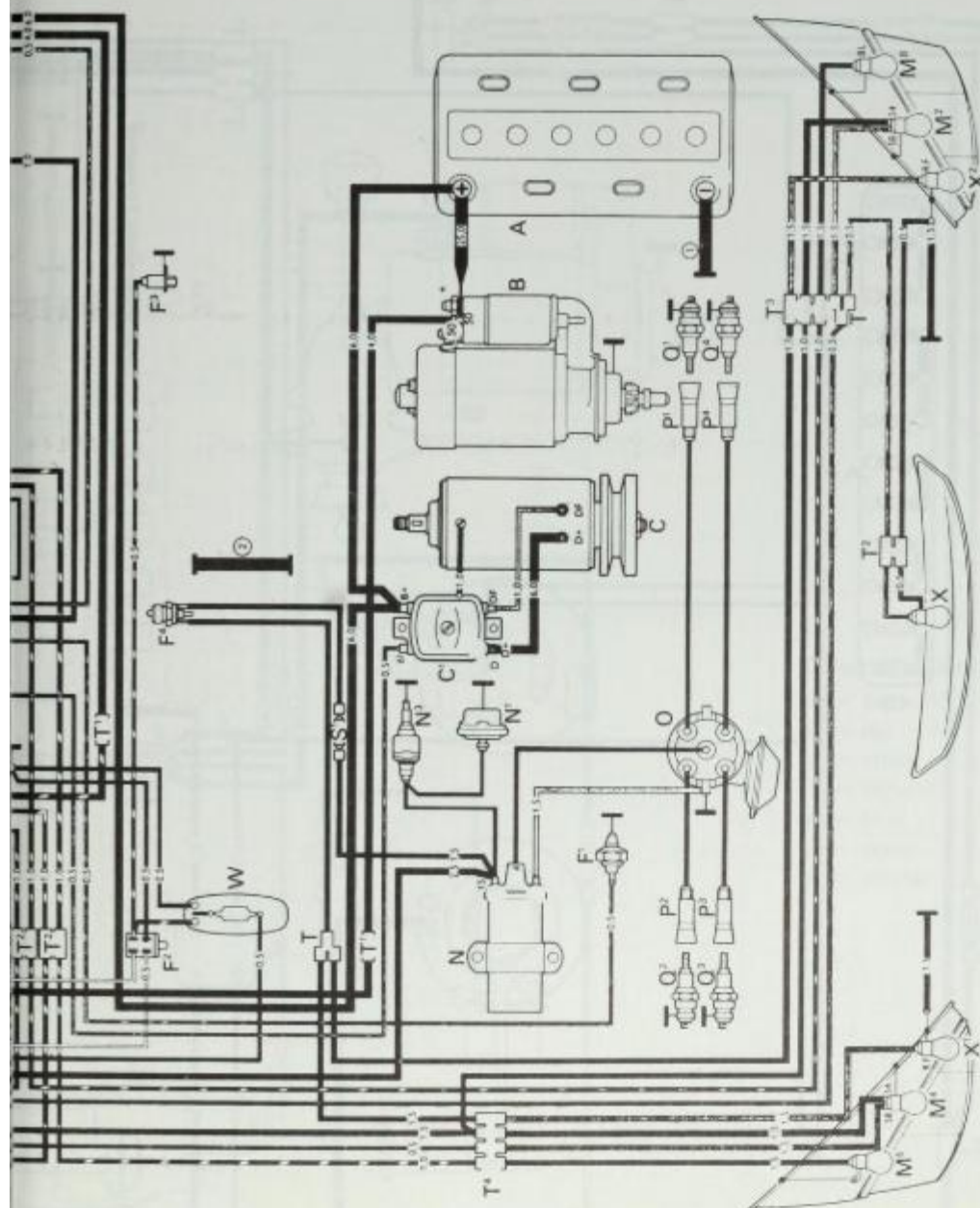


NOTE

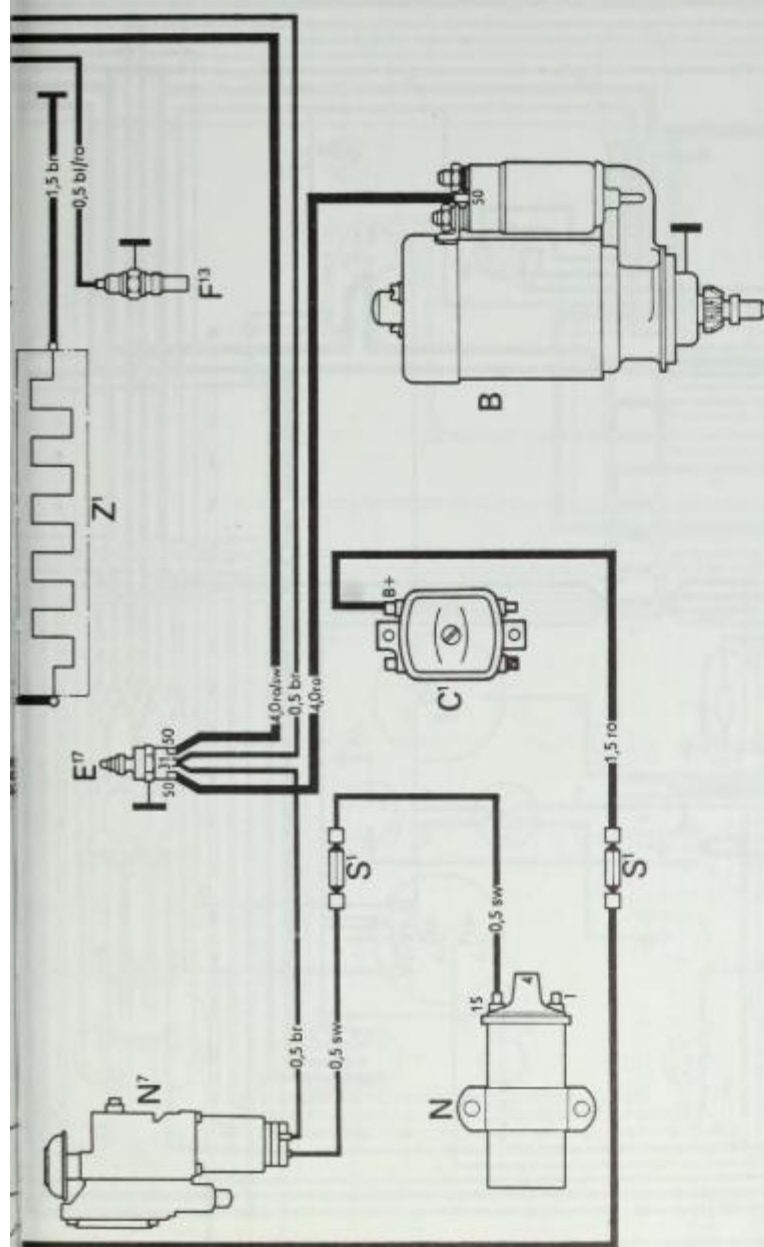
For 1972 models, see Page 145.

- H¹ - Horn
- H² - Ignition key warning buzzer
- J - Dimmer relay
- J² - Emergency flasher relay
- J⁴ - Fuel gauge vibrator
- K¹ - High beam warning light
- K² - Generator charging warning light
- K³ - Oil pressure warning light
- K⁴ - Turn signal warning light
- K⁵ - Emergency flasher warning light
- K⁷ - Dual circuit brake warning light
- L¹ - Sealed-Beam unit, left headlight
- L² - Sealed-Beam unit, right headlight
- L¹⁰ - Instrument panel light
- M¹ - Parking light, left
- M² - Tail / brake light, right
- M⁴ - Tail / brake light, left

- S - Fuse box
- S¹ - Back-up light in-line fuse
- T - Cable adapter
- T¹ - Cable connector, single
- T² - Cable connector, double
- T³ - Cable connector, triple
- T⁴ - Cable connector (four connections)
- T⁵ - Cable connector (five connections)
- V - Windshield wiper motor
- W - Interior light
- X - License plate light
- X¹ - Back-up light, left
- X² - Back-up light, right
- ① - Ground strap from battery to frame
- ② - Ground strap from transmission to frame
- ④ - Ground cable from front axle to frame



- B – Starter
 C' – Regulator
 D – Ignition/starter switch
 d – To ignition/starter switch, terminal 50
 E' – Light switch
 E² – Turn signal and headlight dimmer switch
 E⁹ – Fan motor switch
 E¹⁵ – Rear window defogger switch
 E¹⁷ – Starter cut-out switch
 E²¹ – Contact at selector lever
 F¹³ – ATF temperature sensor
 J⁹ – Rear window defogger relay
 K⁹ – ATF temperature warning light
 K¹⁰ – Rear window defogger warning light
 N – Ignition coil
 N⁷ – Automatic Stick Shift control valve
 S – Fuse box
 S¹ – Fuse for:
 rear window defogger,
 Automatic Stick Shift control valve,
 fan motor
 T¹ – Cable connector, single
 T² – Cable connector, double
 V² – Fan motor
 Z¹ – Rear window defogger heating element

**Color of cables:**

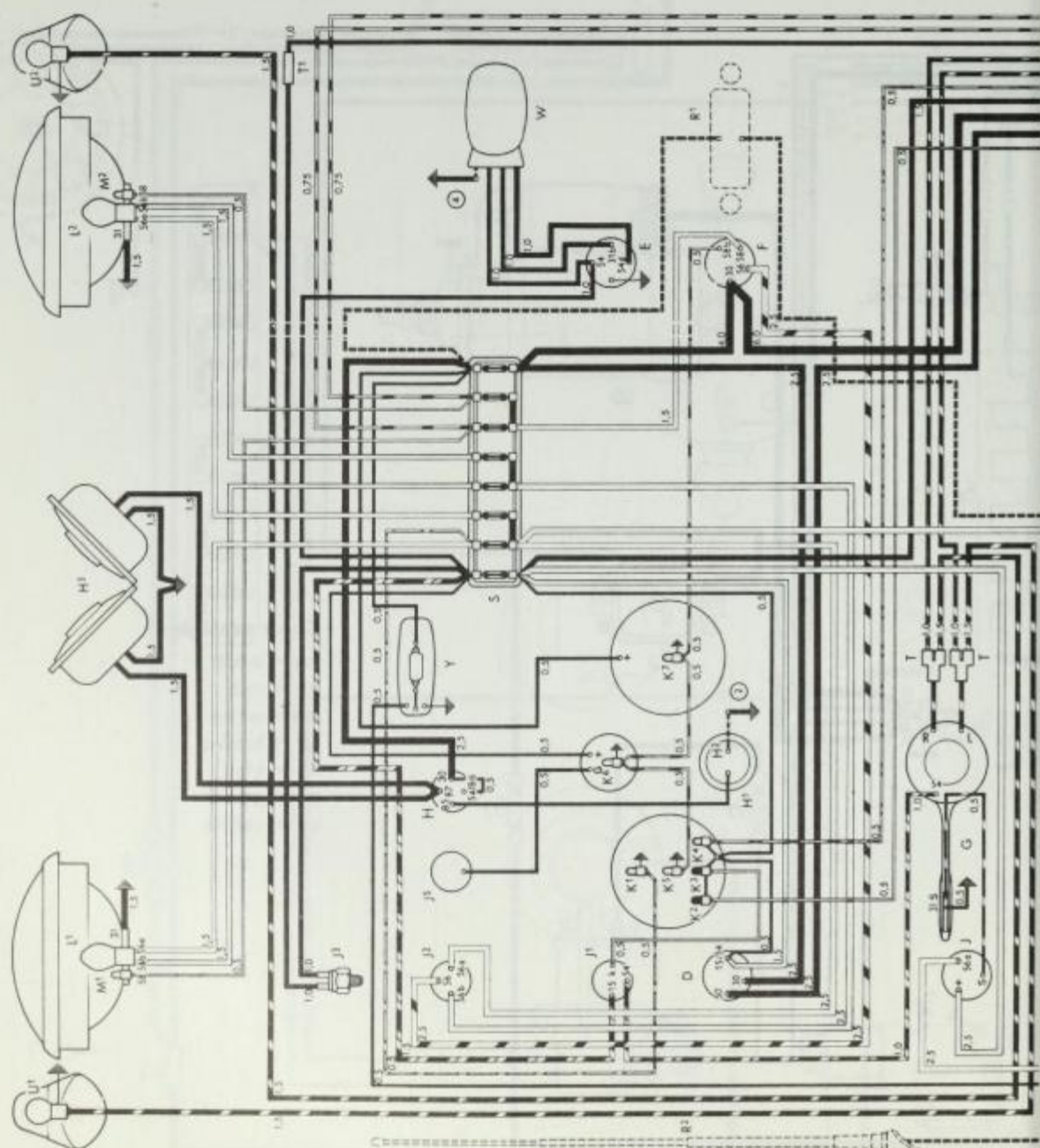
sw = black
 ro = red
 ws = white
 br = brown
 bl = blue
 gn = green
 ge = yellow

WIRING DIAGRAM — 1961-1966 KARMANN GHIA

A - Battery
 B - Starter
 C - Generator
 D - Ignition/starter switch
 E - Windshield wiper switch
 F - Lighting switch and instrument panel light control
 G - Indicator switch light with headlight flasher
 H - Twin horn relay
 H¹ - Horn ring

H² - Steering column connection
 H³ - Twin horn
 J - Headlight flasher relay
 J¹ - Indicator flasher relay
 J² - Dimmer switch
 J³ - Stop light switch
 J⁴ - Oil pressure switch
 J⁵ - Fuel gauge sender unit
 K¹ - High beam warning light
 K² - Generator control light
 K³ - Indicator control light

K⁴ - Oil pressure control light
 K⁵ - Speedometer light
 K⁶ - Fuel gauge light
 K⁷ - Clock light
 L¹ - Bifilament bulb for headlight, left or sealed-beam insert, left
 L² - Bifilament bulb for headlight, right or sealed-beam insert, right
 M¹ - Parking light, left
 M² - Parking light, right
 M³ - Parking light, sealed-beam insert, left



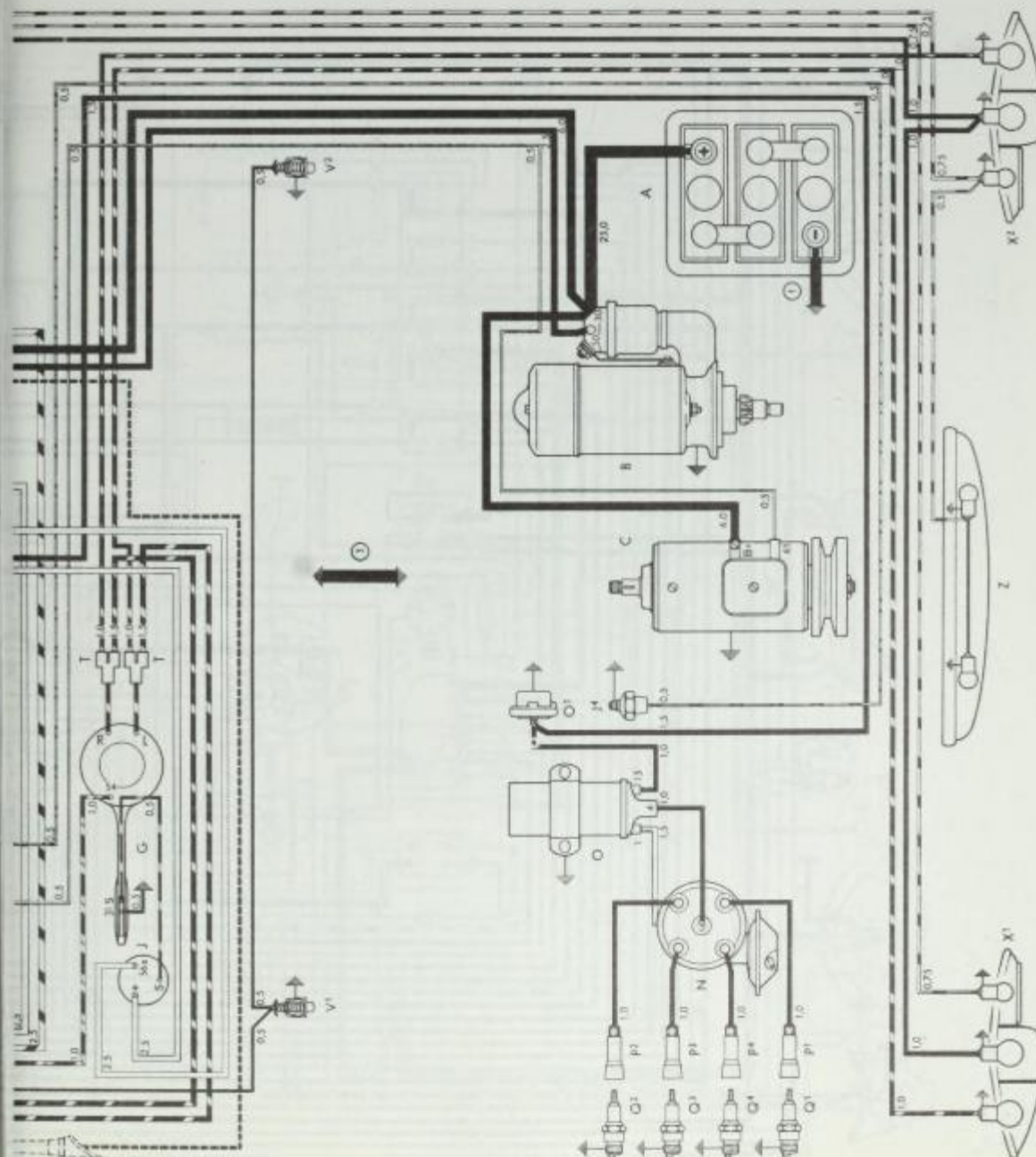
M⁴ - Parking light, sealed-beam insert, right
 N - Ignition distributor
 O - Ignition coil
 O¹ - Automatic choke
 P¹ - Spark plug connector, No. 1 cylinder
 P² - Spark plug connector, No. 2 cylinder
 P³ - Spark plug connector, No. 3 cylinder
 P⁴ - Spark plug connector, No. 4 cylinder
 Q¹ - Spark plug for No. 1 cylinder
 Q² - Spark plug for No. 2 cylinder
 Q³ - Spark plug for No. 3 cylinder

Q⁴ - Spark plug for No. 4 cylinder
 R¹ - Radio
 R² - Antenna
 S - Fuse box
 T - Cable connector
 T¹ - Cable connector, single
 U¹ - Front indicator light, left
 U² - Front indicator light, right
 V¹ - Door contact switch, left
 V² - Door contact switch, right
 W - Windshield wiper motor
 (3 connections)

X¹ - Indicator, stop and tail light, left
 X² - Indicator, stop and tail light, right
 Y - Interior light
 Z - License plate light

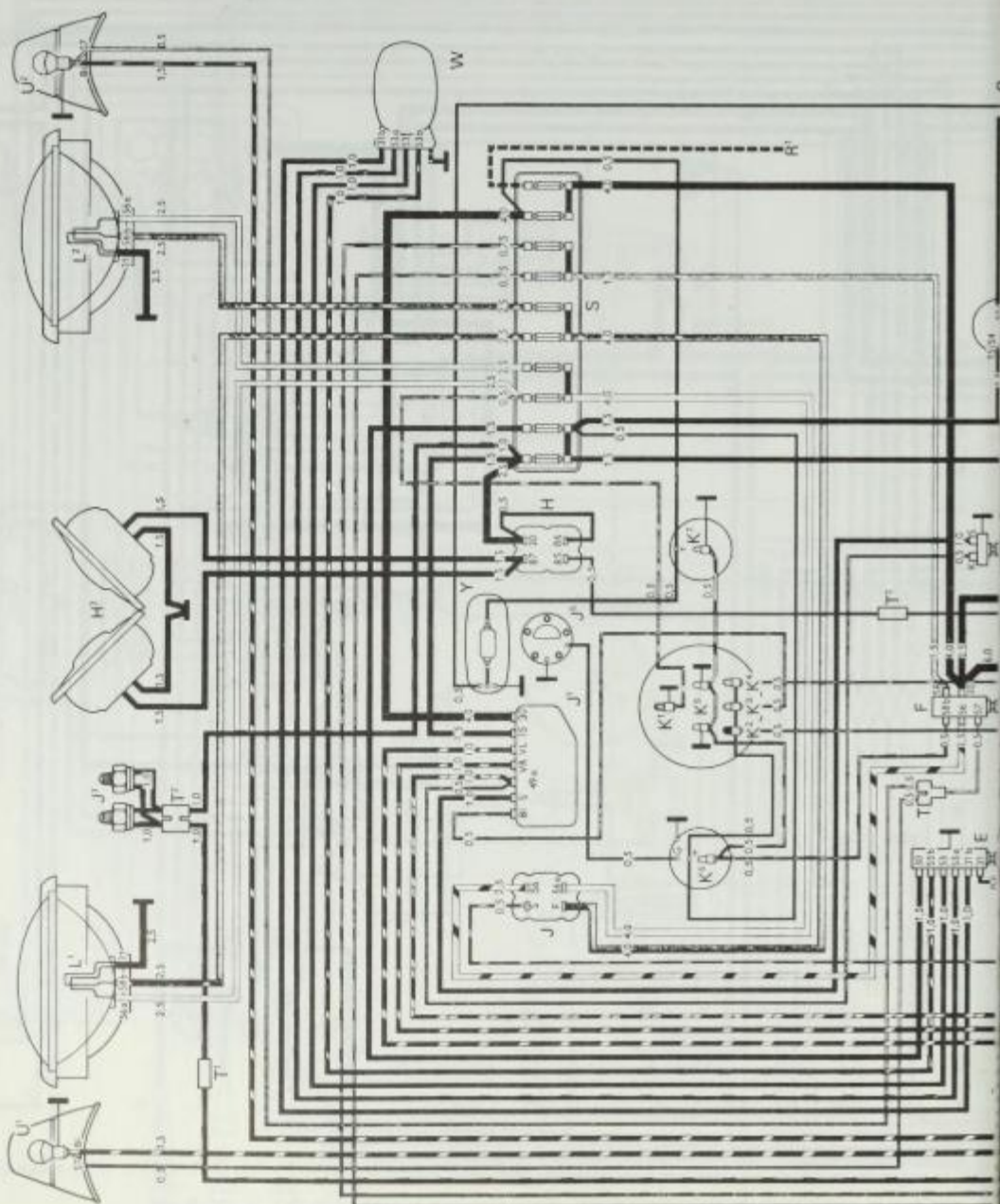
- ① - Battery ground strap
- ② - Steering column flange ground strap
- ③ - Transmission to frame ground strap
- ④ - Windshield wiper motor to body ground strap

Black dotted line = Service Installation



WIRING DIAGRAM — 1967-1968 KARMANN GHIA

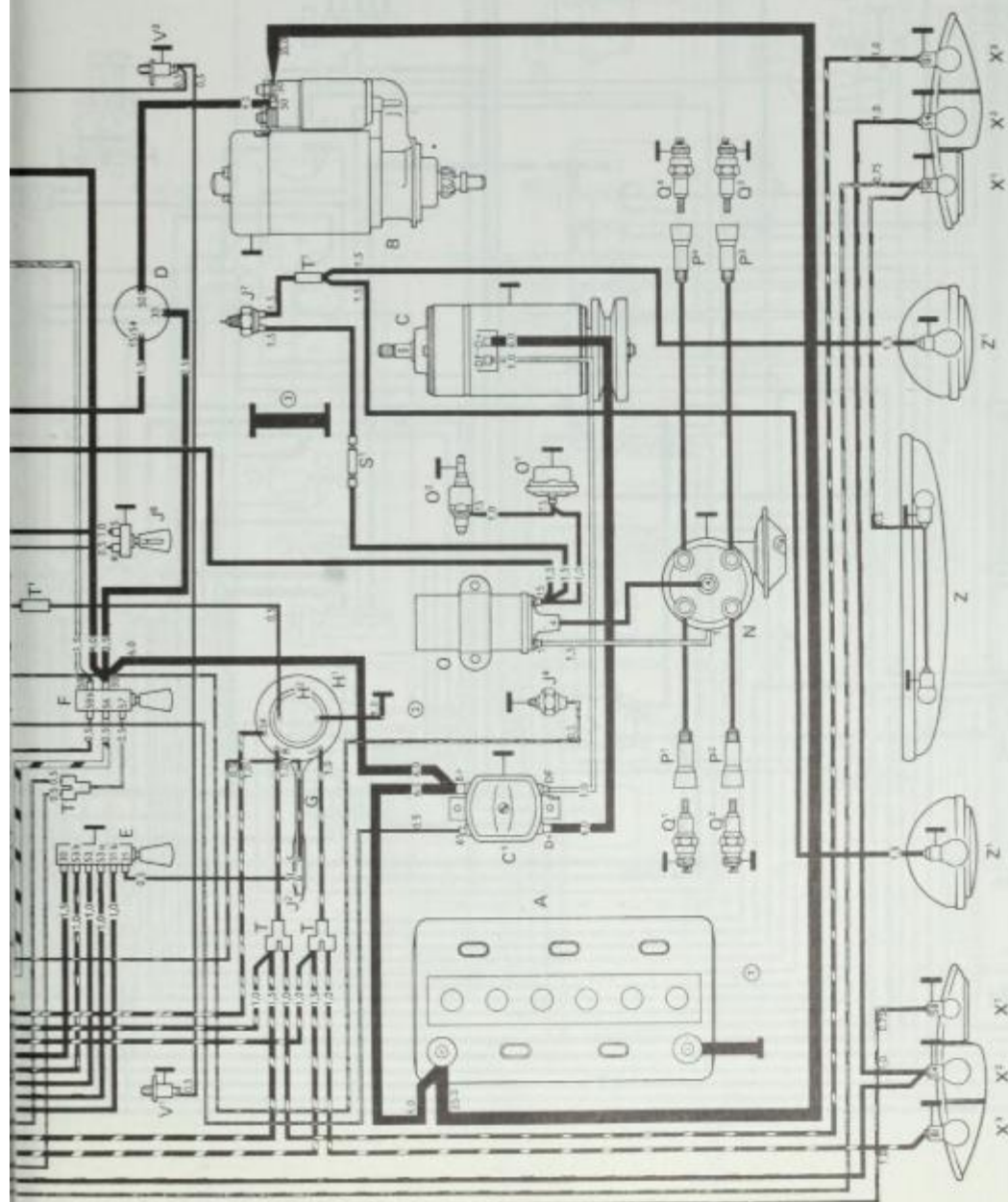
- | | |
|---|---|
| A — Battery | J ³ — Brake light switch (2x) |
| B — Starter | J ⁴ — Oil pressure switch |
| C — Generator | J ⁵ — Fuel gauge sender unit |
| C ¹ — Regulator | J ⁶ — Hazard warning light switch and warning lamp |
| D — Ignition/starter switch | J ⁷ — Back-up light switch (on transmission) |
| E — Windshield wiper switch | K ¹ — High beam warning lamp |
| F — Lighting switch | K ² — Generator charging warning lamp |
| G — Turn signal switch with automatic canceling and headlight flasher | K ³ — Turn signal warning lamp |
| H — Twin horn relay | K ⁴ — Oil pressure warning lamp |
| H ¹ — Horn half ring | K ⁵ — Speedometer lights |
| H ² — Steering column connection | K ⁶ — Fuel gauge light |
| H ³ — Twin horn | K ⁷ — Clock light |
| J — Dimmer relay | L ¹ — Sealed-Beam insert, left |
| J ¹ — Turn signal and hazard warning light relay | L ² — Sealed-Beam insert, right |
| J ² — Dimmer switch | N — Distributor |



- O — Ignition coil
- O¹ — Automatic choke
- O² — Electro-magnetic pilot jet
- P¹ — Spark plug connector, No. 2 cylinder
- P² — Spark plug connector, No. 3 cylinder
- P³ — Spark plug connector, No. 4 cylinder
- P⁴ — Spark plug connector, No. 1 cylinder
- Q¹ — Spark plug for No. 2 cylinder
- Q² — Spark plug for No. 3 cylinder
- Q³ — Spark plug for No. 4 cylinder
- Q⁴ — Spark plug for No. 1 cylinder
- R¹ — Radio connection
- S — Fuse box
- T — Cable adapter
- T¹ — Cable connector, single
- U¹ — Turn signal and parking light, front, left

- U² — Turn signal and parking light, front, right
- V¹ — Door contact switch, left
- V² — Door contact switch, right
- W — Windshield wiper motor
- X¹ — Tail lights
- X² — Brake lights
- X³ — Turn signal lights, rear
- Y — Interior light
- Z — License plate light
- Z¹ — Back-up light

- ① — Battery to frame ground strap
- ② — Steering column flange ground strap
- ③ — Transmission to frame ground cable

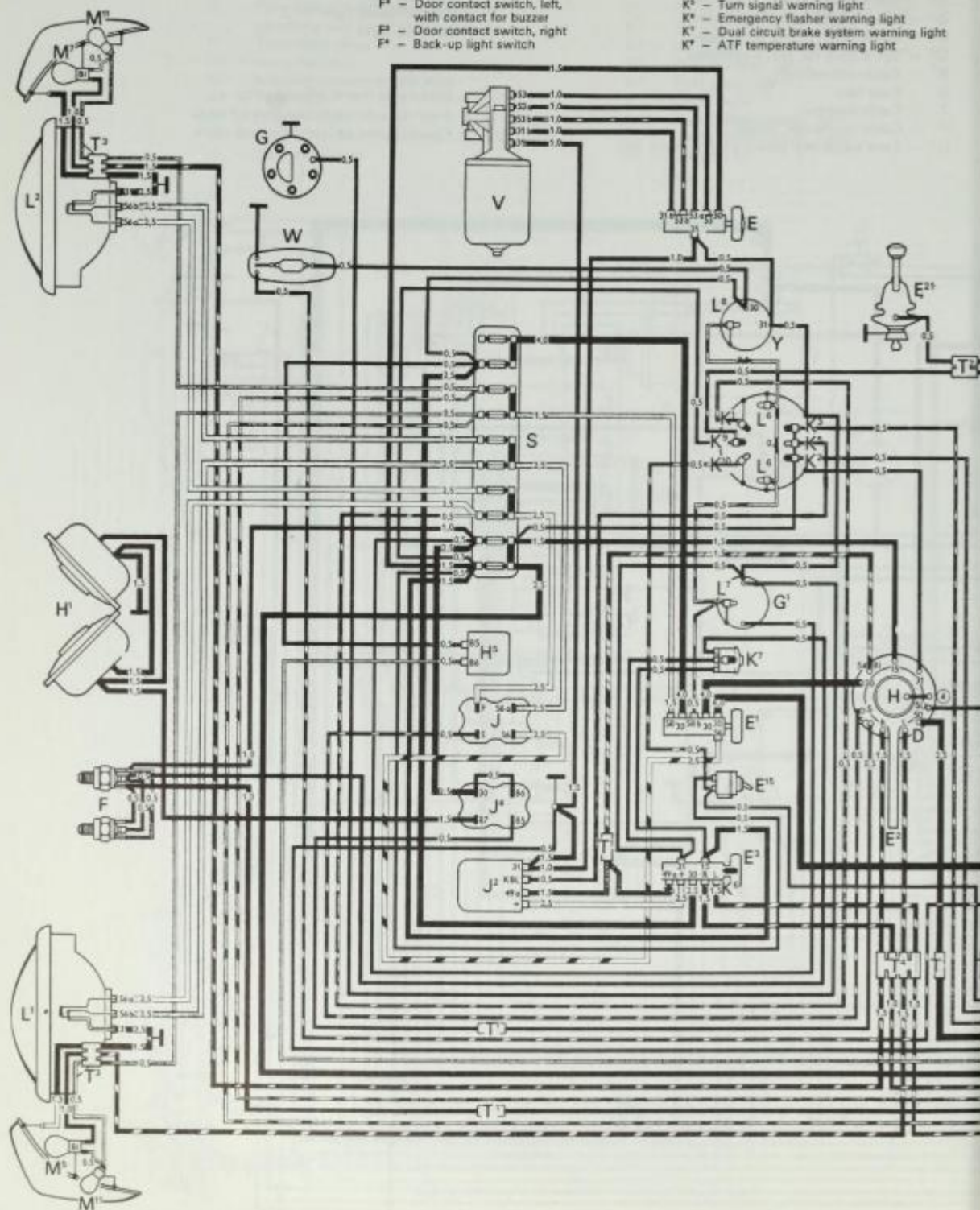


WIRING DIAGRAM —

1969-1970

KARMANN GHIA

- A — Battery
 B — Starter
 C — Generator
 C' — Regulator
 D — Ignition/starter switch
 E — Windshield wiper switch
 E' — Light switch
 E¹ — Turn signal and headlight dimmer switch
 E² — Emergency flasher switch
 E¹² — Switch for rear window defogger
 E¹³ — Starter cut-out switch
 E¹⁴ — Contact at selector lever
 F — Brake light switch with warning switch
 F¹ — Oil pressure switch
 F² — Door contact switch, left, with contact for buzzer
 F³ — Door contact switch, right
 F⁴ — Back-up light switch
 F¹² — Temperature sensor
 F¹⁴ — ATF temperature sensor selector
 G — Fuel gauge sending unit
 G' — Fuel gauge
 H — Horn button
 H¹ — Twin horns
 H² — Ignition key warning buzzer
 J — Dimmer relay
 J² — Emergency flasher relay
 J⁴ — Relay for twin horns
 J⁵ — Rear window defogger relay
 K¹ — High beam warning light
 K² — Generator charging warning light
 K³ — Oil pressure warning light
 K⁴ — Turn signal warning light
 K⁵ — Emergency flasher warning light
 K⁶ — Dual circuit brake system warning light
 K⁷ — ATF temperature warning light

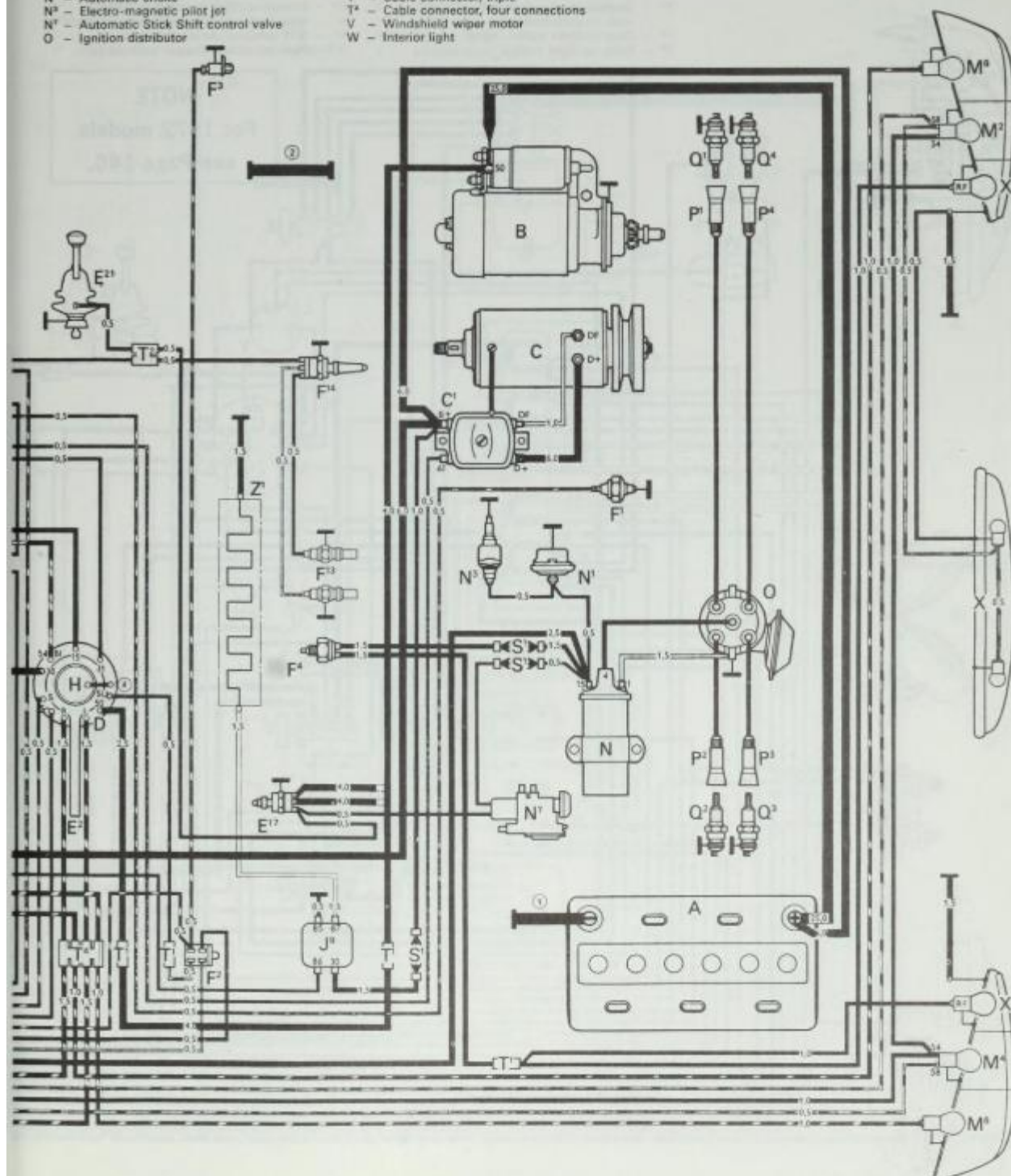


K¹⁴ - Rear window defogger warning light
 L¹ - Sealed beam unit, left headlight
 L² - Sealed beam unit, right headlight
 L³ - Speedometer light
 L⁴ - Fuel gauge light
 L⁵ - Clock light
 M² - Tail and brake light, right
 M³ - Tail and brake light, left
 M⁴ - Turn signal and parking light, front, left
 M⁵ - Turn signal, rear, left
 M⁶ - Turn signal and parking light, front, right
 M⁷ - Turn signal, rear, right
 M⁸ - Side marker light, front
 N - Ignition coil
 N¹ - Automatic choke
 N² - Electro-magnetic pilot jet
 N³ - Automatic Stick Shift control valve
 O - Ignition distributor

P¹ - Spark plug connector, No. 1 cylinder
 P² - Spark plug connector, No. 2 cylinder
 P³ - Spark plug connector, No. 3 cylinder
 P⁴ - Spark plug connector, No. 4 cylinder
 Q¹ - Spark plug, No. 1 cylinder
 Q² - Spark plug, No. 2 cylinder
 Q³ - Spark plug, No. 3 cylinder
 Q⁴ - Spark plug, No. 4 cylinder
 S - Fuse box
 S¹ - Fuse for rear window defogger, back-up lights, Automatic Stick Shift control valve
 T¹ - Cable connector, single
 T² - Cable connector, double
 T³ - Cable connector, triple
 T⁴ - Cable connector, four connections
 V - Windshield wiper motor
 W - Interior light

X - License plate light
 X¹ - Back-up light, left
 X² - Back-up light, right
 Y - Clock
 Z¹ - Rear window defogger heating element

① - Ground strap battery to engine
 ② - Ground strap transmission to frame
 ④ - Ground strap steering column

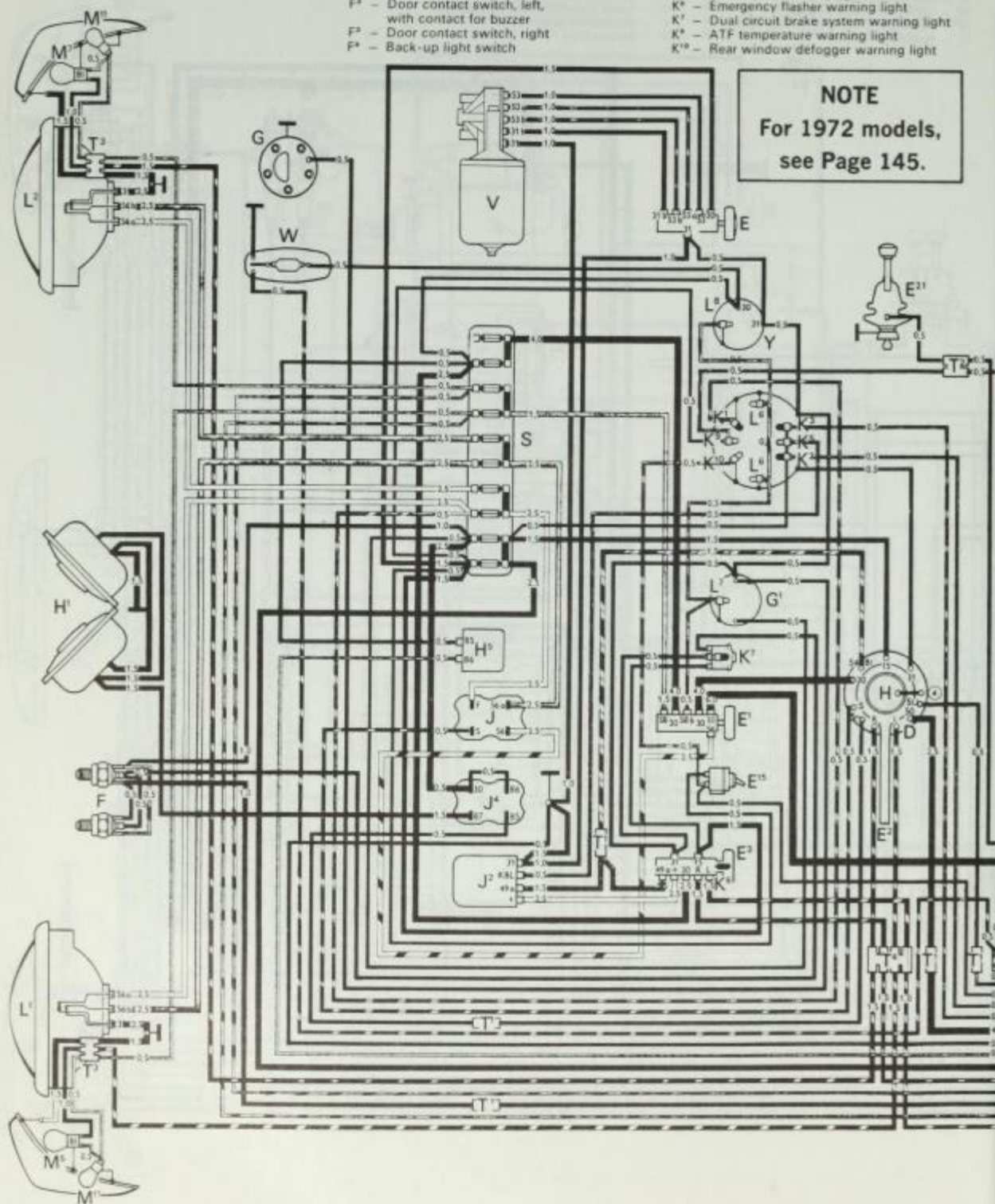


WIRING DIAGRAM —

1971-1972

KARMANN GHIA

- | | |
|---|--|
| A — Battery | F ¹² — ATF temperature sensor |
| B — Starter | G — Fuel gauge sending unit |
| C — Generator | G ¹ — Fuel gauge |
| C ¹ — Regulator | H — Horn button |
| D — Ignition/starter switch | H ¹ — Twin horns |
| E — Windshield wiper switch | H ² — Ignition key warning buzzer |
| E ¹ — Light switch | J — Dimmer relay |
| E ² — Turn signal and headlight dimmer switch | J ² — Emergency flasher relay |
| E ³ — Emergency flasher switch | J ⁴ — Relay for twin horns |
| E ¹⁵ — Switch for rear window defogger | J ⁵ — Rear window defogger relay |
| E ¹⁷ — Starter cut-out switch | K ¹ — High beam warning light |
| E ²¹ — Contact at selector lever | K ¹ — Generator charging control light |
| F — Brake light switch with warning switch | K ² — Oil pressure control light |
| F ¹ — Oil pressure switch | K ³ — Turn signal warning light |
| F ² — Door contact switch, left, with contact for buzzer | K ⁴ — Emergency flasher warning light |
| F ³ — Door contact switch, right | K ⁷ — Dual circuit brake system warning light |
| F ⁴ — Back-up light switch | K ⁸ — ATF temperature warning light |
| | K ¹⁰ — Rear window defogger warning light |



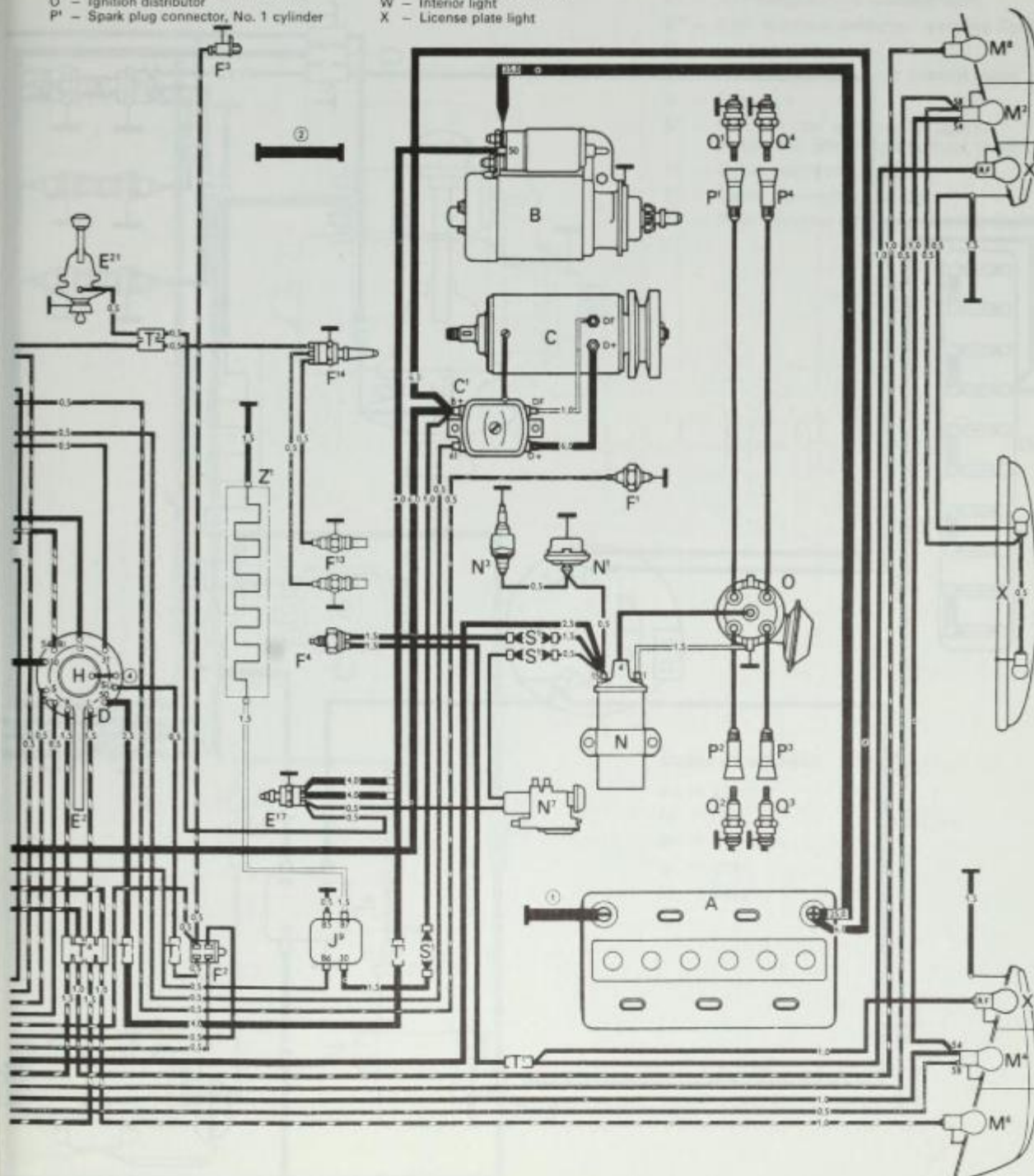
NOTE
For 1972 models,
see Page 145.

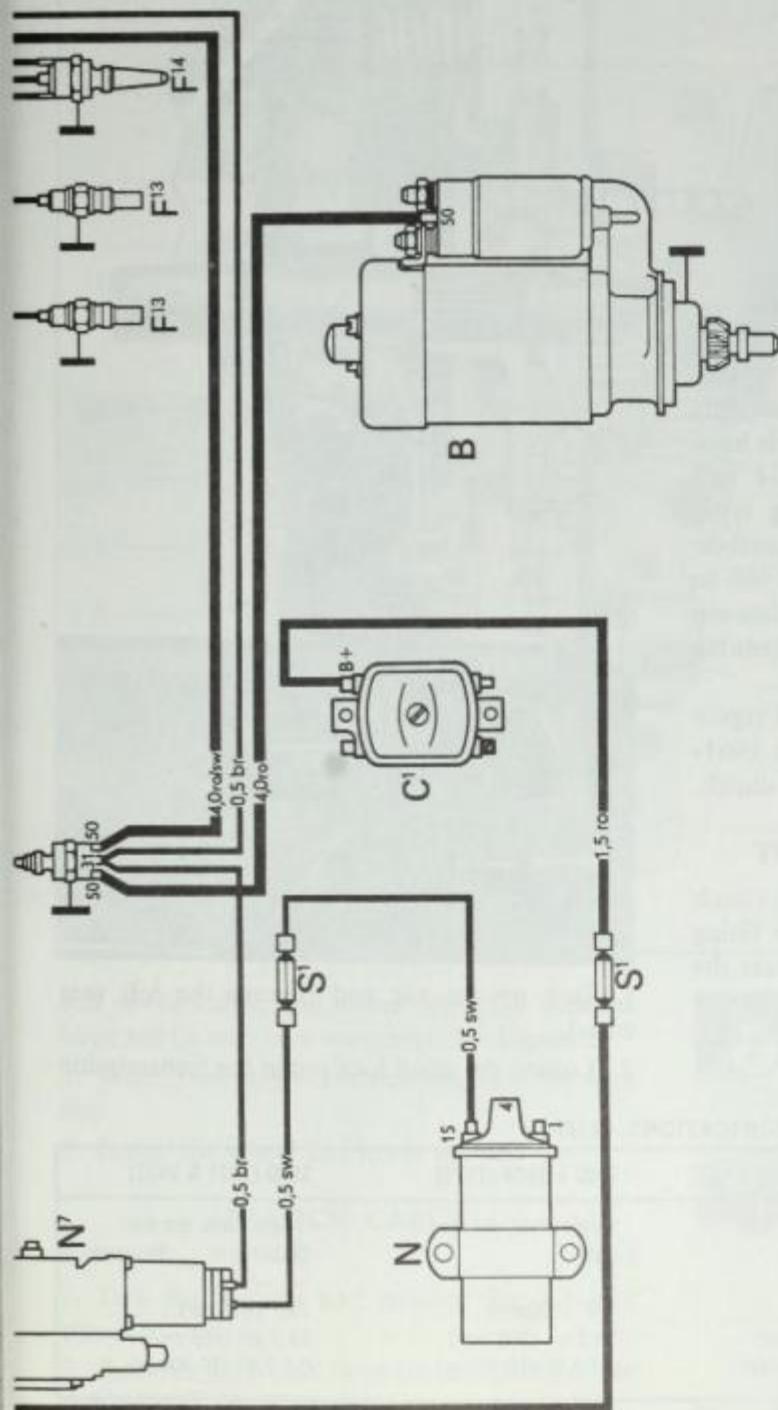
L¹ - Sealed beam unit, left headlight
 L² - Sealed beam unit, right headlight
 L³ - Speedometer light
 L⁴ - Fuel gauge light
 L⁵ - Clock light
 M¹ - Tail and brake light, right
 M² - Tail and brake light, left
 M³ - Turn signal and parking light, front, left
 M⁴ - Turn signal, rear, left
 M⁵ - Turn signal and parking light, front, right
 M⁶ - Turn signal, rear, right
 M⁷ - Side marker light, front
 N - Ignition coil
 N¹ - Automatic choke
 N² - Electromagnetic pilot jet
 N³ - Automatic Stick Shift control valve
 O - Ignition distributor
 P¹ - Spark plug connector, No. 1 cylinder

P² - Spark plug connector, No. 2 cylinder
 P³ - Spark plug connector, No. 3 cylinder
 P⁴ - Spark plug connector, No. 4 cylinder
 Q¹ - Spark plug, No. 1 cylinder
 Q² - Spark plug, No. 2 cylinder
 Q³ - Spark plug, No. 3 cylinder
 Q⁴ - Spark plug, No. 4 cylinder
 S - Fuse box
 S¹ - Fuse for rear window defogger
 back-up lights, Automatic
 Stick Shift control valve
 T¹ - Cable connector, single
 T² - Cable connector, double
 T³ - Cable connector, triple
 T⁴ - Cable connector, four connections
 V - Windshield wiper motor
 W - Interior light
 X - License plate light

X¹ - Back-up light, left
 X² - Back-up light, right
 Y - Clock
 Z¹ - Rear window defogger heating element

① - Ground strap battery to engine
 ② - Ground strap transmission to frame
 ④ - Ground strap steering column





- B – Starter
- C¹ – Regulator
- D – To ignition/starter switch, terminal 50
- E¹⁵ – Switch for rear window defogger
- E¹⁷ – Starter cut-out switch
- E²¹ – Contact at selector lever
- F¹³ – Temperature sensor
- F¹⁴ – ATF temperature sensor selector
- J⁹ – Rear window defogger relay
- K⁹ – ATF temperature warning light
- K¹⁰ – Rear window defogger warning light
- N – Ignition coil
- N⁷ – Automatic Stick Shift control valve
- S – Fuse box
- S¹ – Fuse for rear window defogger,
Automatic Stick Shift control valve
- T¹ – Cable connector, single
- T² – Cable connector, double
- Z¹ – Rear window defogger heating element

Color of cables:

- sw = black
ro = red
br = brown
gr = grey
bl = blue

CHAPTER EIGHT

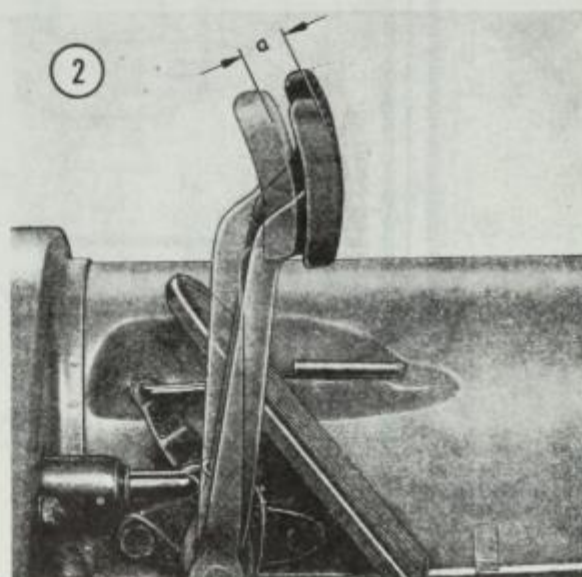
CLUTCH

VW clutches are single, dry disc-types mounted on the flywheel. The 1961-1970 models have a coil spring pressure plate, while 1971 and 1972 models have a diaphragm spring type. From 1961-1965, Volkswagen used a carbon clutch release bearing, but changed in 1966 to a conventional ball bearing type. All models are mechanically operated through an adjustable wire cable.

This chapter includes adjustment and repair procedures for all clutch variations from 1961-1972. **Figure 1** shows components of the clutch.

CLUTCH PEDAL ADJUSTMENT

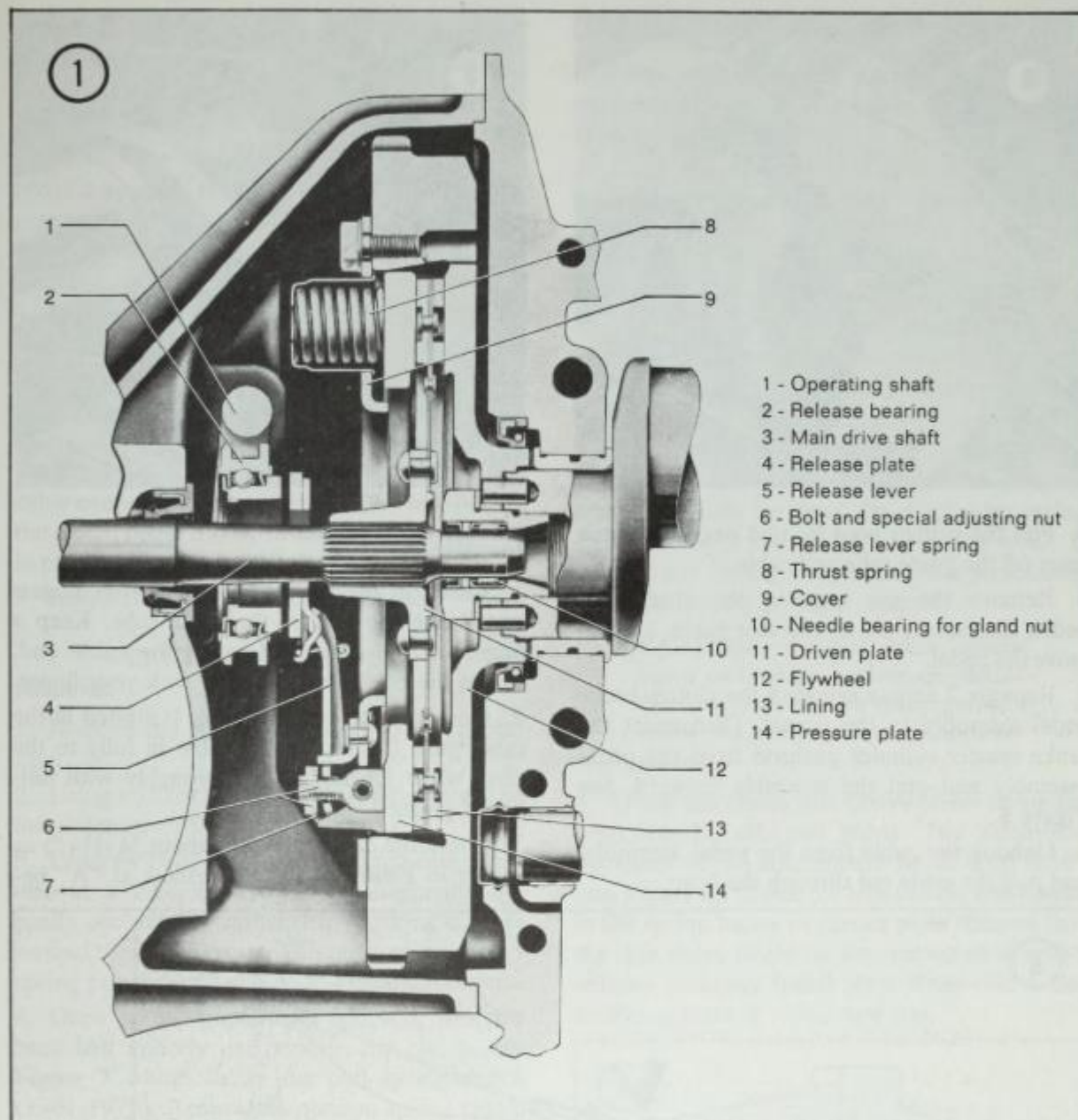
Clutch adjustment involves taking up clutch cable slack caused by cable stretch and lining wear. To check clutch adjustment, depress the clutch pedal by hand. Free play should be $\frac{1}{2}$ - $\frac{3}{4}$ ". See **Figure 2**. If its more or less than this, adjust the cable as follows.



1. Jack up the car and remove the left rear wheel.
2. Loosen the small lock nut at the transmission

SPECIFICATIONS, CLUTCH

	1200 & 1300	1500 & 1600 (1970)	1600 (1971 & 1972)
Type	Single plate, dry disc	Single plate, dry disc	Single plate, dry disc
Spring type	Coil	Coil	Diaphragm
No. of spring	6	9	- - -
Diameter	7.1" (180mm)	7.8" (200mm)	7.8" (200mm)
Friction area	41.6 in ² (268 cm ²)	56.3 in ² (363 cm ²)	56.3 in ² (363 cm ²)
Pedal free-play	0.4-0.8" (10-20mm)	0.4-0.8" (10-20mm)	0.4-0.8" (10-20mm)



end of the cable, and adjust free play with the large nut (it may be a wing nut). See **Figure 3**.

3. When free play is correct, retighten the lock nut.

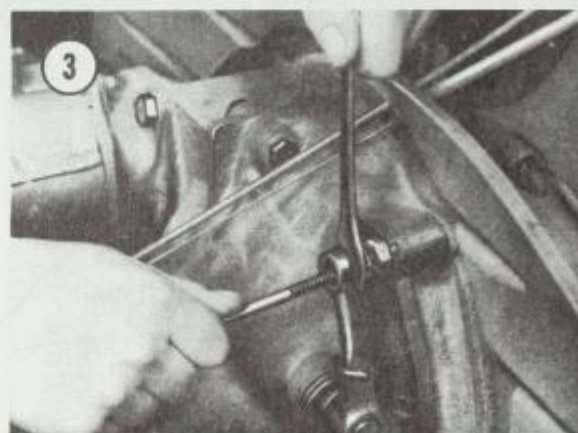
4. Install the wheel and lower the car.

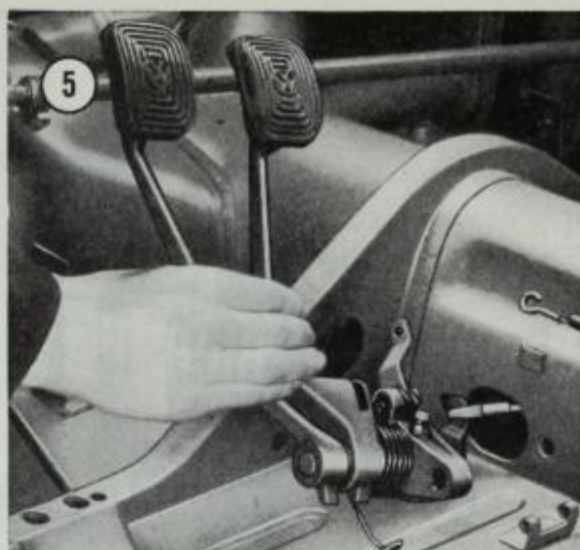
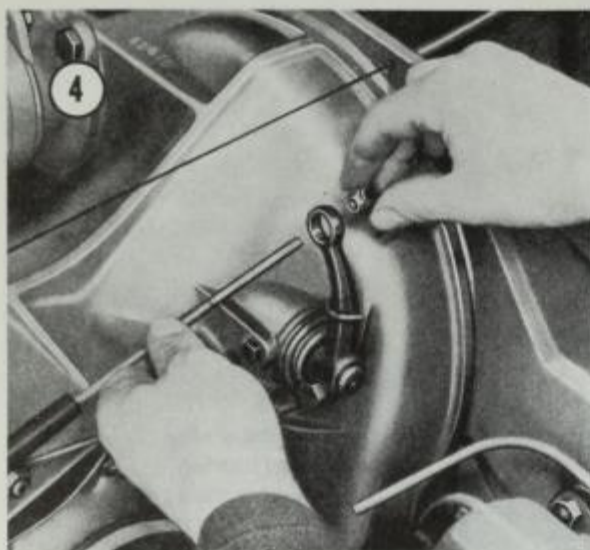
CLUTCH CABLE

Removal

1. Jack the car up and remove the left rear wheel.

2. Remove both nuts from the cable end at the clutch lever. See **Figure 4**.





3. Pull the rubber boot located near the clutch lever off the guide tube and cable.

4. Remove the pin securing the accelerator pedal, disconnect the accelerator cable, and remove the pedal.

5. Remove 2 screws securing the clutch/brake pedal assembly to the tunnel. Disconnect the brake master cylinder pushrod from the pedal assembly and pull the assembly forward. See **Figure 5**.

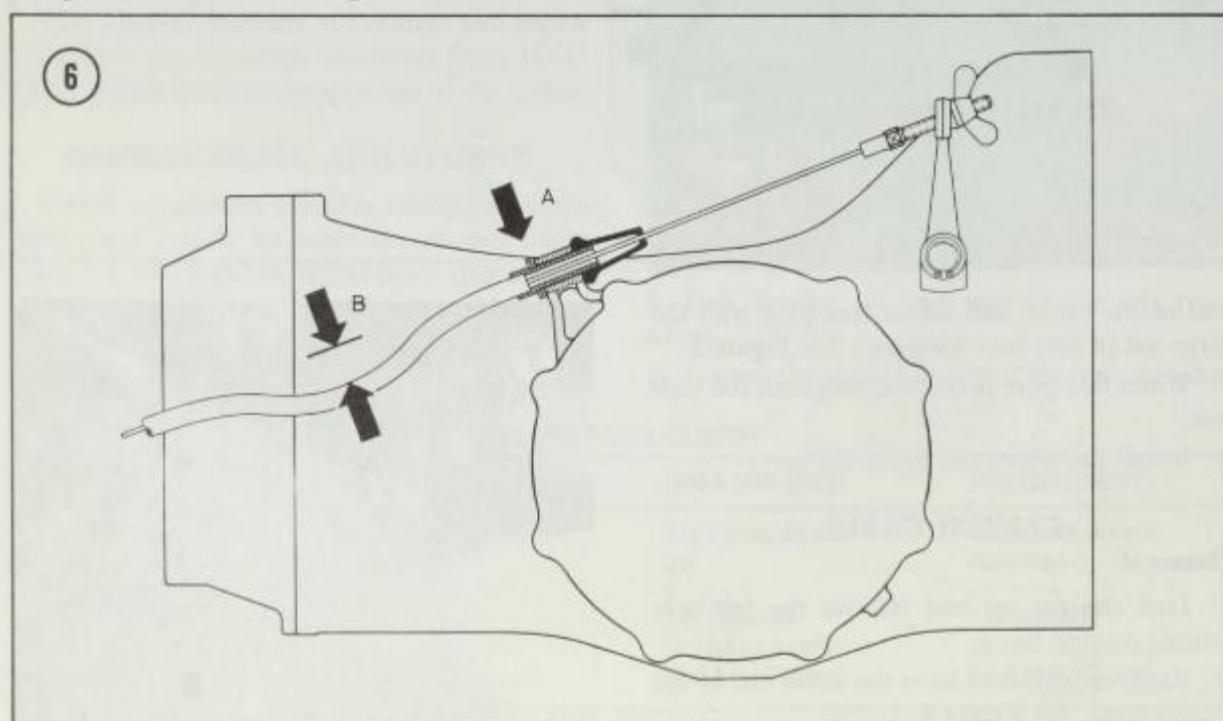
6. Unhook the cable from the pedal assembly, and pull the cable out through the front.

Installation

1. Reach in the tunnel hole with your fingers and locate the end of the cable tube. Keep a finger on the tube, and insert the cable end. Guide the cable into the tube with your finger.

2. Once you are sure the cable is started in the tube, push the rest of the cable in fully to the rear, while lubricating it thoroughly with universal grease.

3. Check the cable tube sag (about $\frac{3}{4}$ -1 $\frac{1}{4}$ ") as shown in **Figure 6**. Install washers at "A" be-



tween the holding bracket and cable tube end to vary the sag. Cable sag introduces a controlled amount of friction in the cable to minimize clutch chatter.

4. Grease the cable eye and hook it on the pedal assembly. Have an assistant pull on the rear end to maintain tension on the cable. Otherwise the cable eye will fall off the pedal assembly.

5. Install pedal assembly with 2 bolts. Reconnect the master cylinder pushrod and the accelerator pedal.

6. While maintaining tension on the cable, put the rear cable end into the clutch lever. Screw the large nut (sometimes a wing nut) on the cable end until there is about $\frac{1}{2}$ - $\frac{3}{4}$ " free play in the clutch pedal travel. Install the small lock nut in place to hold the adjustment.

7. Install the wheel and lower the car.

CLUTCH MECHANISM

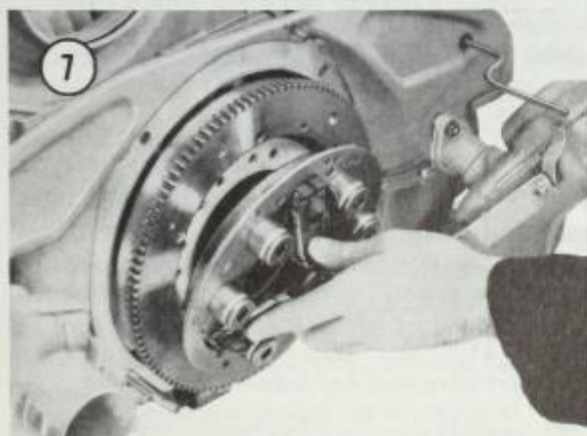
Removal

1. Remove the engine as described in Chapter Four.

2. Using a sharp punch, mark the flywheel and the clutch cover for later reassembly.

3. Unscrew bolts securing the clutch cover, one turn at a time. Unscrew bolts diagonally opposite one another rather than working directly around the clutch cover. This ensures that heavy spring pressure will not warp the clutch cover.

4. Once spring pressure is relieved, unscrew each bolt entirely and remove the clutch. See **Figure 7** which shows the coil spring clutch (1961-1970). Remove diaphragm spring clutch (1971-1972) in a similar manner.



Inspection

Never replace clutch parts without giving thought to the reason for failure. To do so only invites repeated troubles.

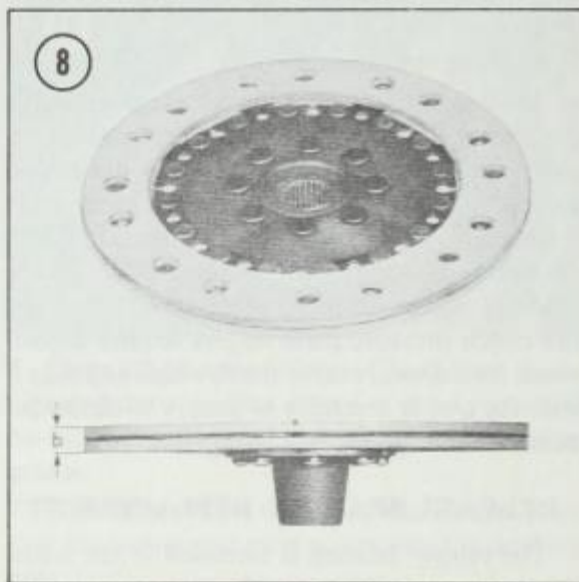
1. Clean the flywheel face and pressure plate assembly in a non-petroleum base cleaner such as trichloroethylene.

2. Check the friction surface of the flywheel for cracks and grooves. Attach a dial indicator and check run-out. Compare with specifications for your engine. If necessary, have the flywheel re-ground; replace it in cases of severe damage.

3. Check the pressure plate for cracked or broken springs, evidence of heat, cracked or scored friction surface and looseness. Check release lever ends for wear. On diaphragm spring clutches, check the spring fingers for wear. If there is any damage, replace with a professionally rebuilt pressure plate assembly.

CAUTION: *Pressure plate adjustments and repairs require specialized tools and skills. Do not attempt repairs unless you are properly equipped for the job.*

4. Check the clutch disc (drive plate) lining for wear, cracks, oil, and burns. The assembled thickness of the disc should be at least 0.36" (see **Figure 8**). Check for loose rivets and cracks in the spring leaves or carrier plate. Ensure that the disc slides freely on the transmission spline without excessive radial play. If the disc is defective, replace it with a new one.



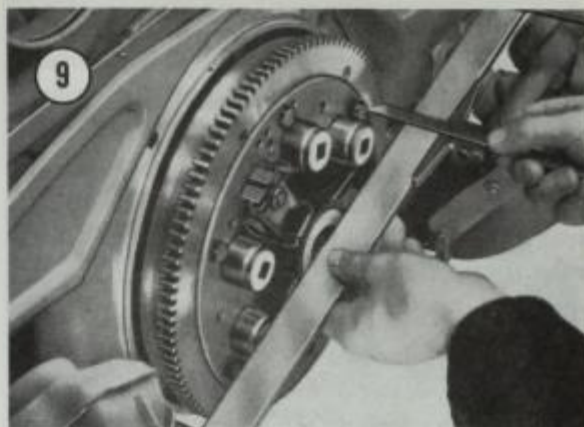
5. Check the release bearing for wear to determine if it caused the original trouble. Never reuse a release bearing unless necessary. When other clutch parts are worn, the bearing is probably worn. If it is necessary to reinstall the old bearing, do not wash it in solvent; wipe it with a clean cloth.

Installation

1. Wash your hands **clean** before proceeding.
2. Sand the friction surface of the flywheel and pressure plate with a medium-fine emery cloth. Sand lightly across the surfaces (not around) until they are covered with fine scratches. This breaks the glaze and aids seating a new clutch disc.
3. Clean the flywheel and pressure plate with trichloroethylene or equivalent.
4. Insert the clutch disc. Place the pressure plate in position and line up the punch marks made when the clutch was removed. If installing a new or rebuilt pressure plate, align the clutch assembly with the balance marks 180° from each other. The balance marks, painted on the edge of the flywheel and clutch assembly, show the heaviest side of the part.
5. Center the clutch disc over the gland nut hole with a pilot. An excellent pilot is an old transmission main shaft available from a wrecking yard.
6. Start all pressure plate bolts. Tighten diagonally opposite bolts a few turns at a time until all are tight. Torque to 18 foot-pounds (2.5 mkg).
7. Remove the centering pilot.
8. Measure the height of the release plate above the flywheel with a straight edge and depth gauge as shown in **Figure 9**. This dimension should be 1.06-1.18" (26.7-30mm). Measure at 6 (or more) points around the flywheel. If this dimension is not correct, or if any two of the readings are more than 0.02" (0.6mm) apart, the clutch pressure plate fingers require adjustment. To adjust, remove the flywheel and take it with the clutch assembly to your VW dealer for adjustment.

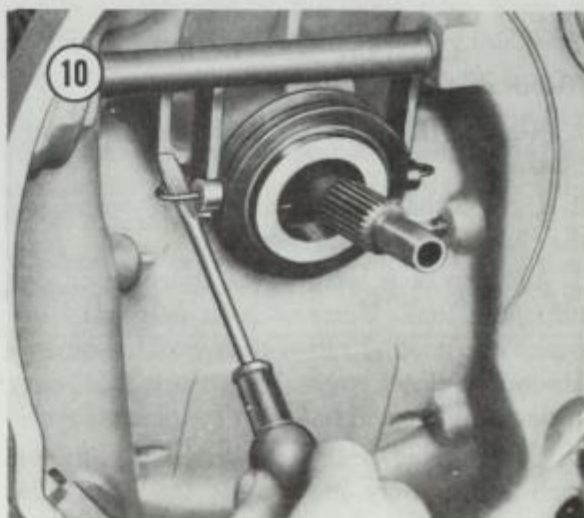
RELEASE BEARING REPLACEMENT

The release bearing is mounted in the transmission case and is accessible after removing the



engine. In addition to checking a suspect release bearing, always remove the clutch assembly from the flywheel and check for damage as described earlier.

1. Unhook the retaining clips as shown in **Figure 10**. Slide the bearing off.

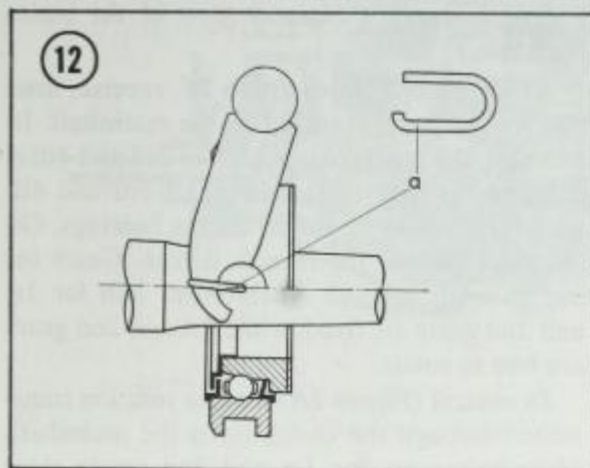
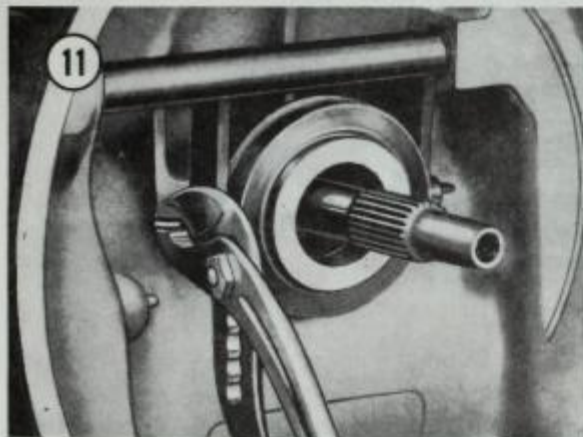


2a. Replace the carbon release bearing if the face is marked or cracked, or worn near the retaining cup. You may consider using one of the newer ball bearing types instead of another carbon block; see your VW dealer for the correct part.

2b. Hold the inner race of the ball-bearing type. Lightly press the outer race against the inner race and rotate the outer race. If there is any noise or roughness, the bearing is defective and must be replaced.

CAUTION: The release bearing is prelubricated and sealed. Do not wash in solvent or the bearing will be ruined. Wipe the bearing with a clean cloth.

3. Before installing the release bearing, lightly sand the plastic ring with medium coarse emery cloth. Lubricate the sanded surface with molybdenum disulfate paste or powder.
4. Lubricate the contact points between the fork and bearing with lithium grease.
5. Install the retaining clips as shown in **Figures 11 and 12**. The small bend in each clip must clip around the fork tightly.

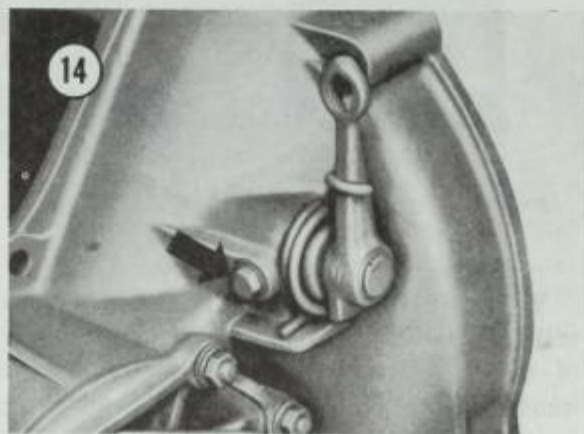
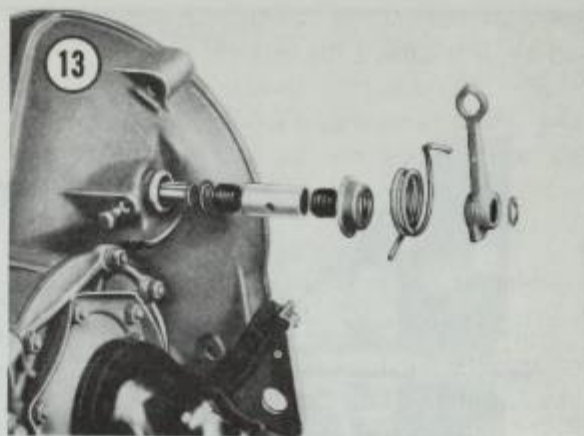


RELEASE LEVER MECHANISM

Whenever the engine is removed, it is a good idea to check the release lever.

Removal/Installation

1. Remove the clutch release bearing as described earlier.
2. On 1961-1964 models, loosen the clamp bolt on the lever. On 1965-1971 models remove the lock ring on the end of the lever shaft. Remove the lever, return spring, and end cap. See **Figure 13**.
3. Remove the bushing lock screw (**Figure 14**).



4. Slide the operating shaft to the left to push the bushing out. Remove the bushing, washer, and spacer sleeve.
5. Slide the operating shaft to the right to remove it. See **Figure 15**.



6. Clean all parts in solvent. Check both bushings and the operating shaft for wear; replace if necessary. Lubricate the shaft with lithium grease.
7. Installation is the reverse of these steps. Note that the lock screw must screw into the bushing hole.

CHAPTER NINE

MANUAL AND AUTOMATIC TRANSAXLES

Volkswagen transmissions mount in a yoke at the rear of the car. The engine bolts to the rear of the transmission. Manual and automatic transmissions are also transaxles, since the housing contains transmission and differential gears sharing a common oil supply. Each transmission is described in detail below.

Repairs requiring disassembly of either transaxle are not possible for home mechanics or garage mechanics without special skills and a large assortment of special VW tools. Most adjustments such as selector fork position and bearing preload are done at VW dealerships on special test jigs; these adjustments are impossible while the parts are installed in the case. The price of the test jigs and other tools necessary far exceeds the cost of a professionally rebuilt transaxle.

Considerable money can be saved by removing the old transmission and installing a new or rebuilt one yourself. This chapter includes removal and installation procedures, plus other simple repairs. Specifications are included at the rear of this chapter. See Chapter Two for lubrication and preventive maintenance.

MANUAL TRANSAXLE

The manual transaxle has 4 forward speeds and one reverse. The gears are in constant mesh

and all forward speeds are fully synchronized. **Figure 1** shows a cutaway view of the entire transaxle.

As shown in **Figures 2A to 2F**, reverse, first, and second gears are fixed on the mainshaft. In addition, the synchronizer hub for 3rd and 4th is fixed on the mainshaft. Mainshaft 3rd and 4th gears are free to rotate on needle bearings. On the drive pinion, the reverse is true. Gears for 3rd and 4th and the synchronizer hub for 1st and 2nd gears are fixed, while 1st and 2nd gears are free to rotate.

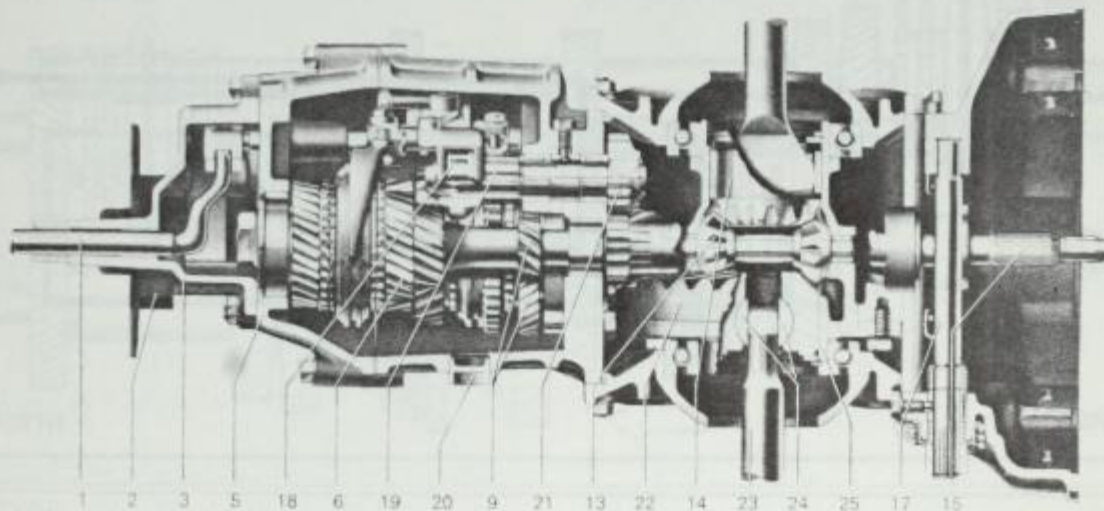
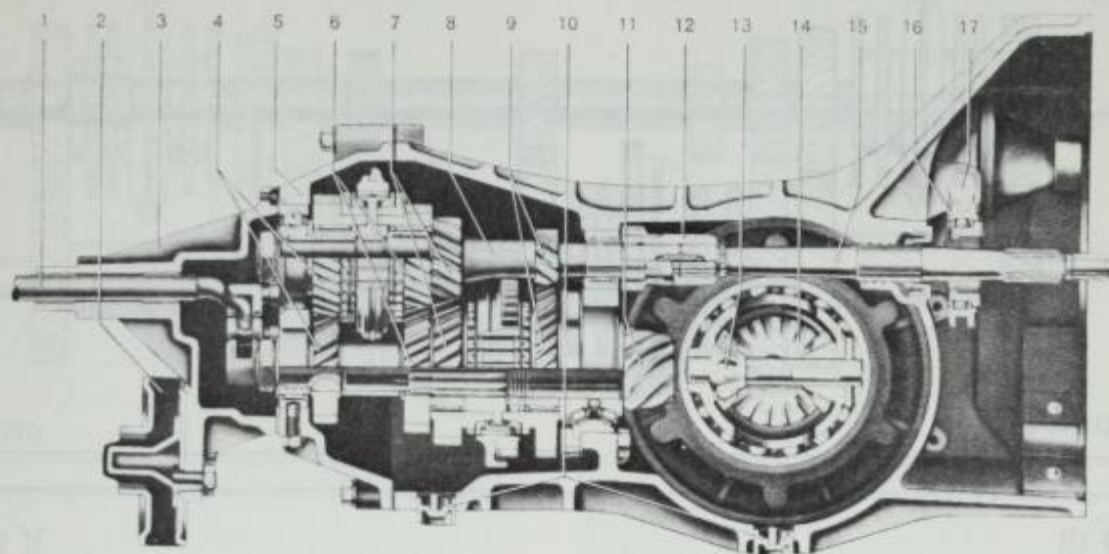
In neutral (**Figure 2A**), engine rotation transmitted through the clutch turns the mainshaft. Mainshaft gears for 1st and 2nd rotate since they are fixed to the shaft. Drive pinion gears for 1st and 2nd, however, are not engaged by the synchronizer and turn freely. No power is transmitted to the pinion gear.

When the gearshift lever is moved to 1st (**Figure 2B**), a fork slides the outer portion of the synchronizer toward 1st gear. Power is transmitted from the mainshaft through both 1st gears to the pinion, which drives the differential.

In 2nd gear (**Figure 2C**), a fork moves the same synchronizer towards 2nd gear. Power is transmitted from the mainshaft through both 2nd gears to the pinion.

Power transfer for 3rd and 4th gears is similar

①



- 1 - Transmission shift lever
- 2 - Bonded rubber mounting
- 3 - Gearshift housing
- 4 - 4th gear
- 5 - Gear carrier
- 6 - 3rd gear
- 7 - 2nd gear
- 8 - Main drive shaft, front
- 9 - 1st gear

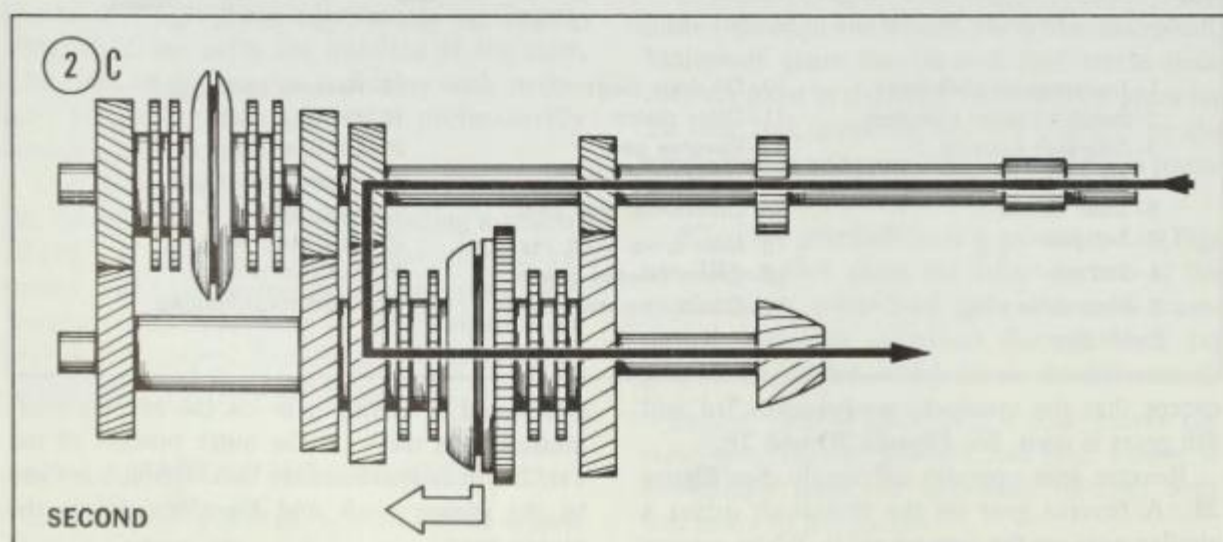
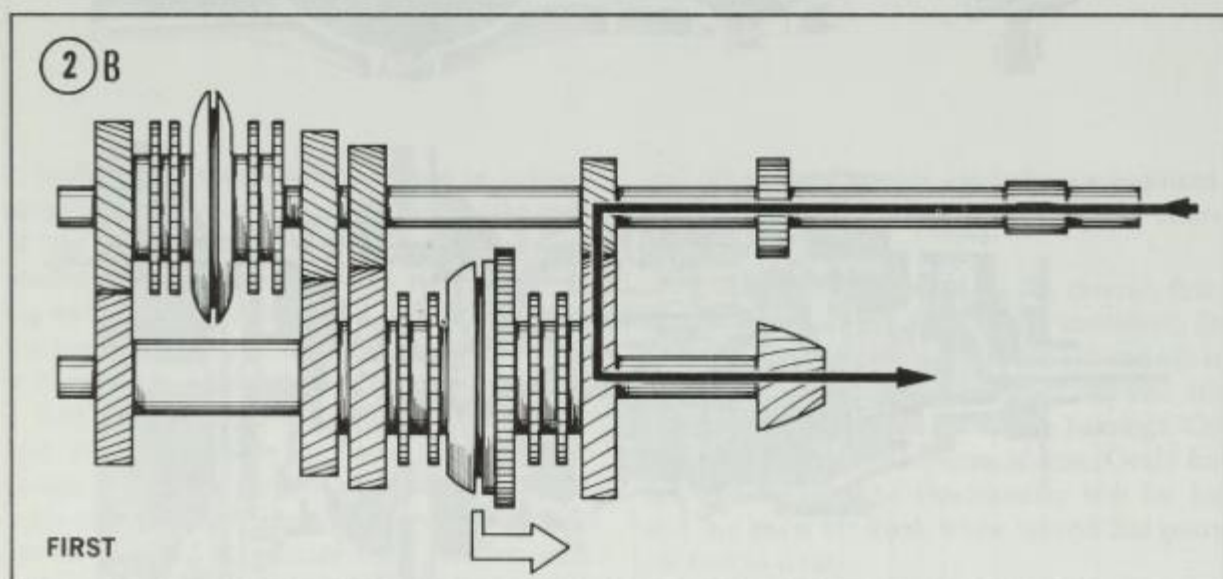
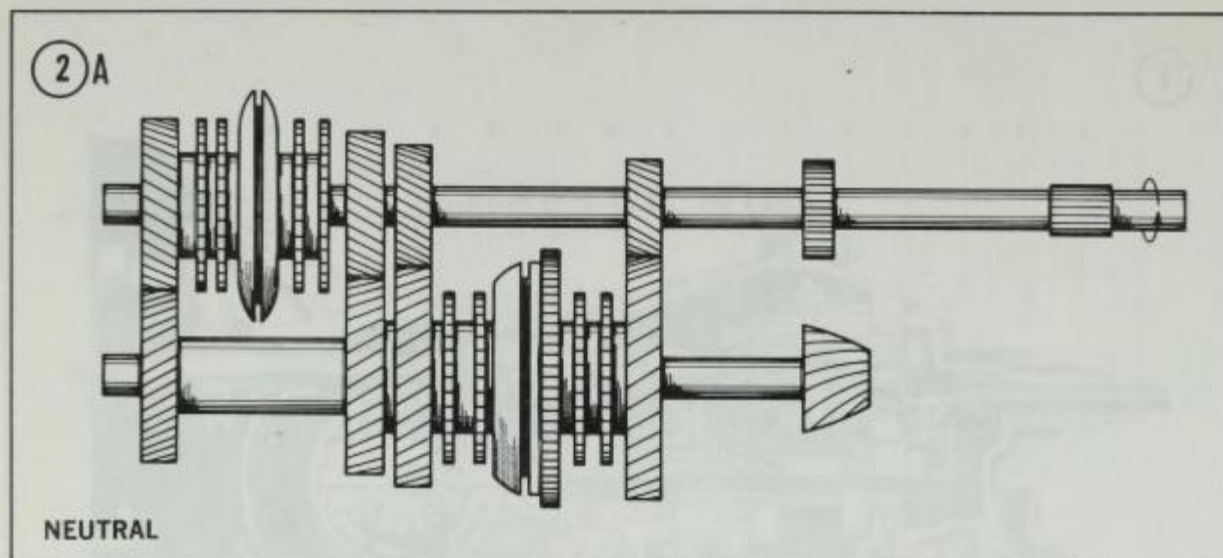
- 10 - Oil drain plugs
- 11 - Drive pinion
- 12 - Reverse gear
- 13 - Differential pinion
- 14 - Differential side gear
- 15 - Main drive shaft, rear
- 16 - Clutch release bearing
- 17 - Clutch operating shaft

- 18 - Reverse sliding gear
- 19 - Reverse shaft
- 20 - Oil filler plug
- 21 - Reverse drive gear
- 22 - Ring gear
- 23 - Rear axle shaft
- 24 - Fulcrum plate
- 25 - Differential housing

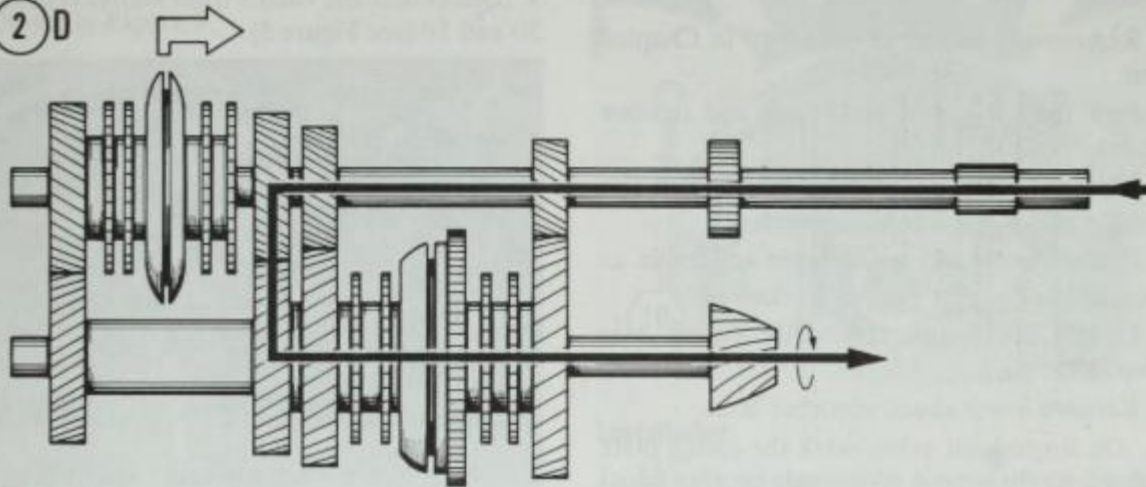
except that the synchronizer between 3rd and 4th gears is used. See **Figures 2D and 2E**.

Reverse gear operates differently. See **Figure 2F**. A reverse gear on the mainshaft drives a similar gear on the reverse shaft. When reverse

is selected, a sliding gear on the reverse shaft meshes with teeth on the outer portion of the 1st/2nd gear synchronizer hub. The hub is fixed to the pinion shaft and therefore drives the pinion gear.

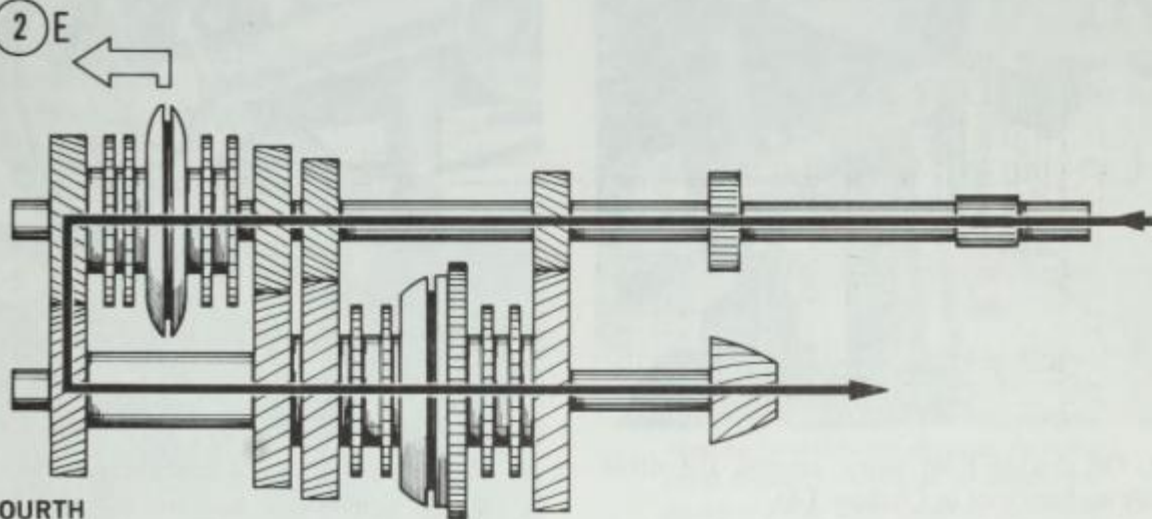


② D



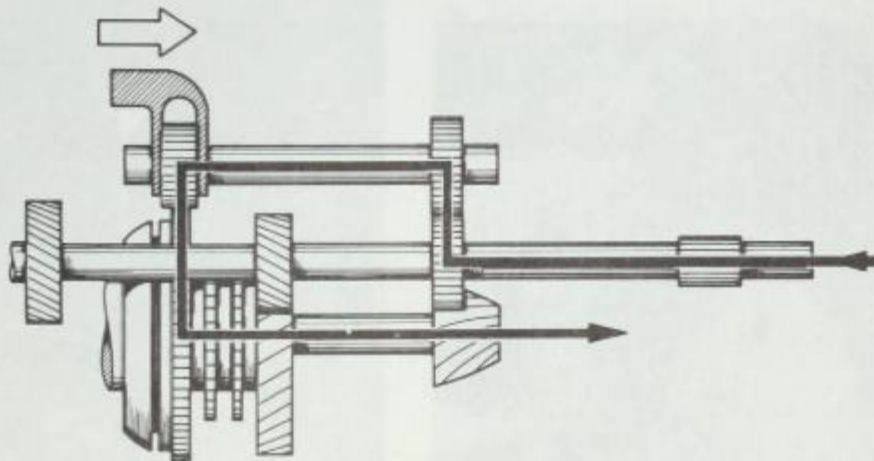
THIRD

② E



FOURTH

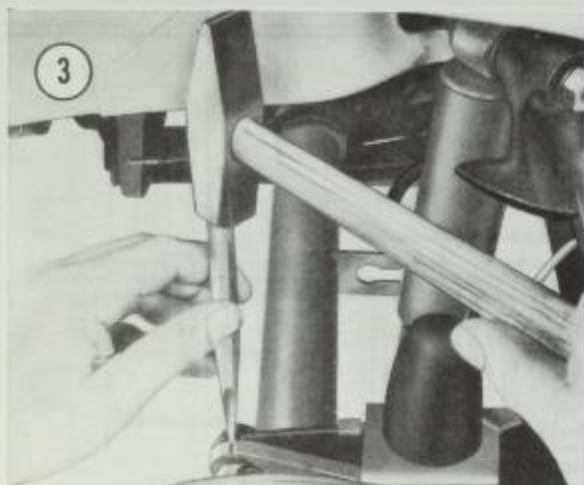
② F



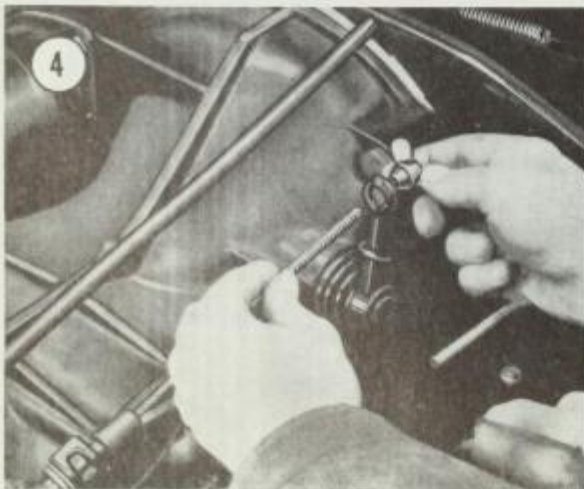
REVERSE

Removal

1. Remove the engine as described in Chapter Four.
2. Jack the car up on jackstands and remove the rear wheels.
3. Disconnect the rear brake hoses from the backing plates.
4. Remove the hand brake lever and cable as described in Chapter Twelve, Brakes.
5. Loosen the clamps around the rubber axle boots.
6. Remove lower shock absorber bolts.
- 7a. On single joint axles, mark the spring plate in line with the groove on the axle bearing housing. See **Figure 3**.



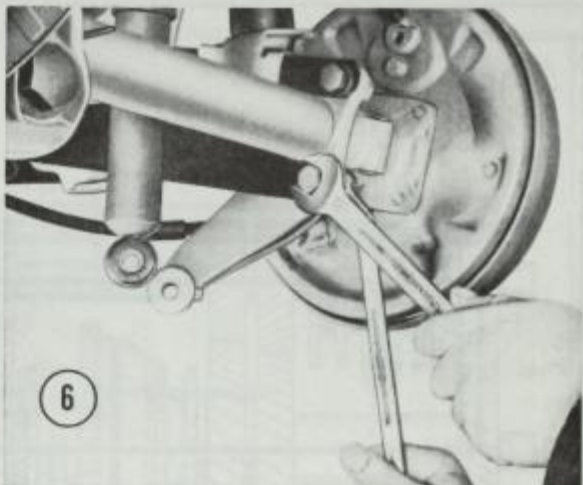
- 7b. On double joint axles, remove the drive shaft as described in Chapter Ten.
8. Disconnect the clutch cable from the transmission operating lever. See **Figure 4**. Withdraw the cable and sleeve.



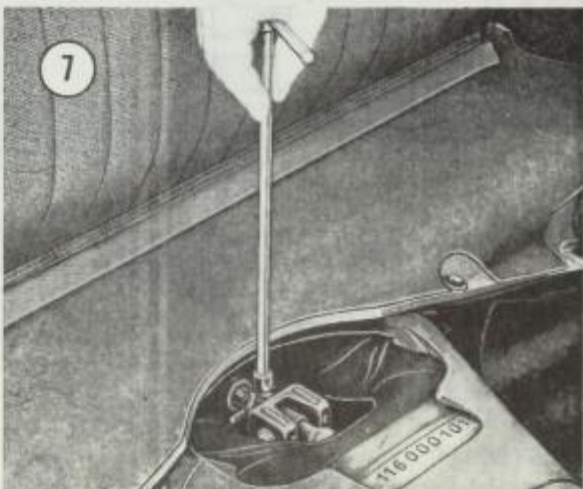
9. Disconnect the cables from starter terminals 30 and 50 (see **Figure 5**).



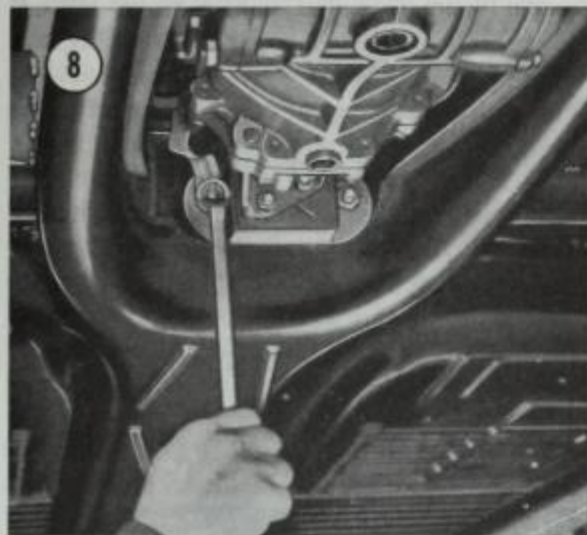
10. Remove bolts at rear axle bearing housing on single joint axles only. See **Figure 6**.



11. Remove the rear seat cushion, and inspection cover. Remove the shift rod coupling bolt. See **Figure 7**. Move the gearshift lever to withdraw the coupling from the transmission shift rod.

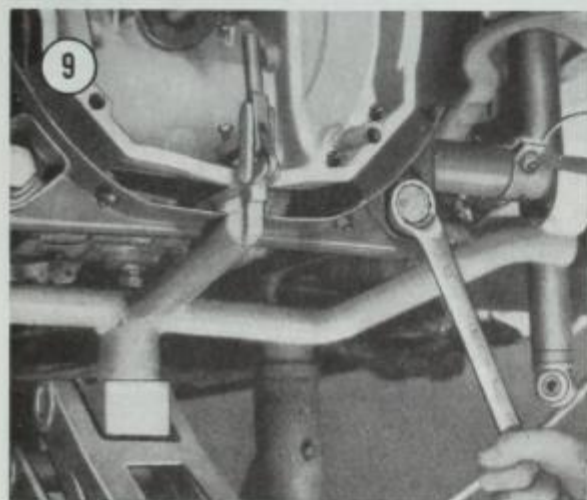


12. Remove the nuts on the front rubber mount as shown in **Figure 8**.



13. Place a garage-type floor jack under the transmission case, and raise it just enough to take the weight of the transmission.

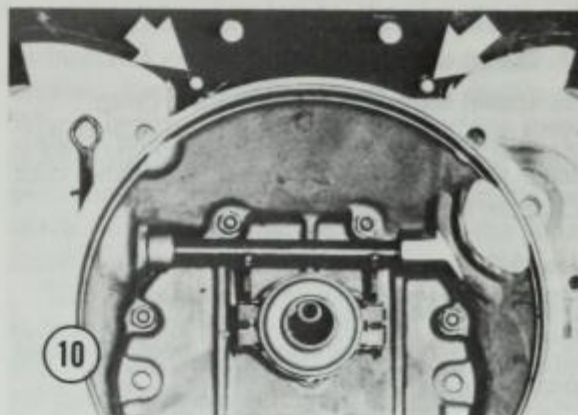
14a. On 1961-1971 transaxles, remove carrier bolts under the transaxle. See **Figure 9**.



14b. On 1972 transaxles, remove carrier bolts at top of transaxle. See **Figure 10**.

15. Withdraw the transaxle towards the rear with the jack.

CAUTION: While the transaxle is out of the car, take special care not to damage or bend the splined mainshaft. One method of protection is to drill a hole in a length of wood for the mainshaft and bolt the wood across the transmission case.



Installation

1. Lift the transaxle into place. Grease the rear carrier bolts and install them. Tighten to 167 foot-pounds (23 mkg).

2. Loosen the 4 nuts inside the bell housing which secure the transaxle to the rear rubber mount. Install the nuts on the front rubber mount and tighten them. Now tighten the rear rubber mount nuts.

3. Reconnect the shift rod coupling to the shift rod. Ensure that the pointed end of the securing bolt fits fully in the rod recess. Lock the bolt securely with wire. Install the inspection cover and seat cushion.

CAUTION: If the coupling is connected incorrectly, it is possible to select reverse when 2nd gear is engaged, causing considerable damage. In some cases it may be difficult or impossible to select 1st or 2nd. Connect the coupling carefully and check engagement of each gear.

4a. On single joint axles, install the bolts between the axle bearing housings and the spring plate. Line up the chisel mark on each spring plate with the groove in the housing. Tighten the bolts to 80 foot-pounds (11 mkg).

4b. On double joint axles, install the drive shaft as described in Chapter Ten.

5. Install and tighten the lower shock absorber mounting bolt.

6. Reconnect the cables to terminals 30 and 50 of the starter.

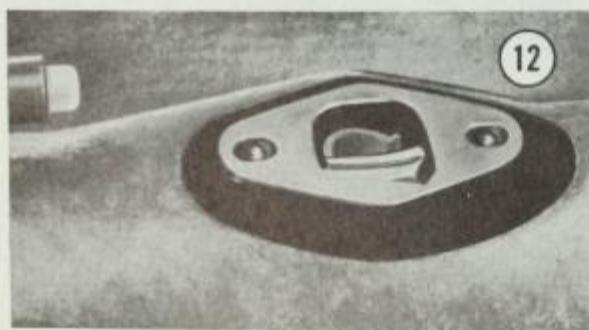
7. Reinstall the clutch cable.

8. Reinstall the handbrake cable and lever. See Chapter Twelve.

9. Reconnect the rear brake hoses.
10. Install the rear wheels.
11. Install the engine. See Chapter Four.
12. Adjust the clutch cable (Chapter Eight), bleed the brakes and adjust the handbrake (Chapter Twelve).

Gearshift Lever Replacement

1. Remove the front floor mat.
2. Remove bolts securing the boot and ball housing to the tunnel.
3. Remove the gearshift lever, ball housing, boot, and spring (see **Figure 11**). Remove the spring by twisting it counterclockwise.
4. Remove the stop plate. See **Figure 12**.



5. Clean all parts in solvent. Check for wear.
6. Grease all moving parts with universal grease.

7. Install the stop plate with the bent tab pointing up (see **Figure 11**).
8. Install the lever ball housing so the lever is vertical in neutral. The locating pin on the bottom of the lever fits in the slot in the ball socket.
9. Ensure that each gear engages properly.

Main Shaft Oil Seal Replacement

1. Remove engine as described in Chapter Four.
2. Remove clutch release bearing. See Chapter Eight.
3. Clean exterior of old seal and surrounding area.
4. Pry oil seal out as shown in **Figure 13**. Do not nick any metal surface.



5. Clean the opening around the main shaft.
6. Coat exterior of the seal lightly with sealing compound. Oil the main shaft and seal lip.
7. Slide oil seal on the main shaft, and drive it into place. Use a special hollow drift or length of pipe as shown in **Figure 14**.



AUTOMATIC STICK SHIFT

The automatic stick shift, introduced in 1968 models, consists of a torque converter, servo operated mechanical clutch, and 3 speed transmission. **Figure 15** is a detailed cutaway view of the transmission. **Figure 16** shows the hydraulic and vacuum circuits in simplified form.

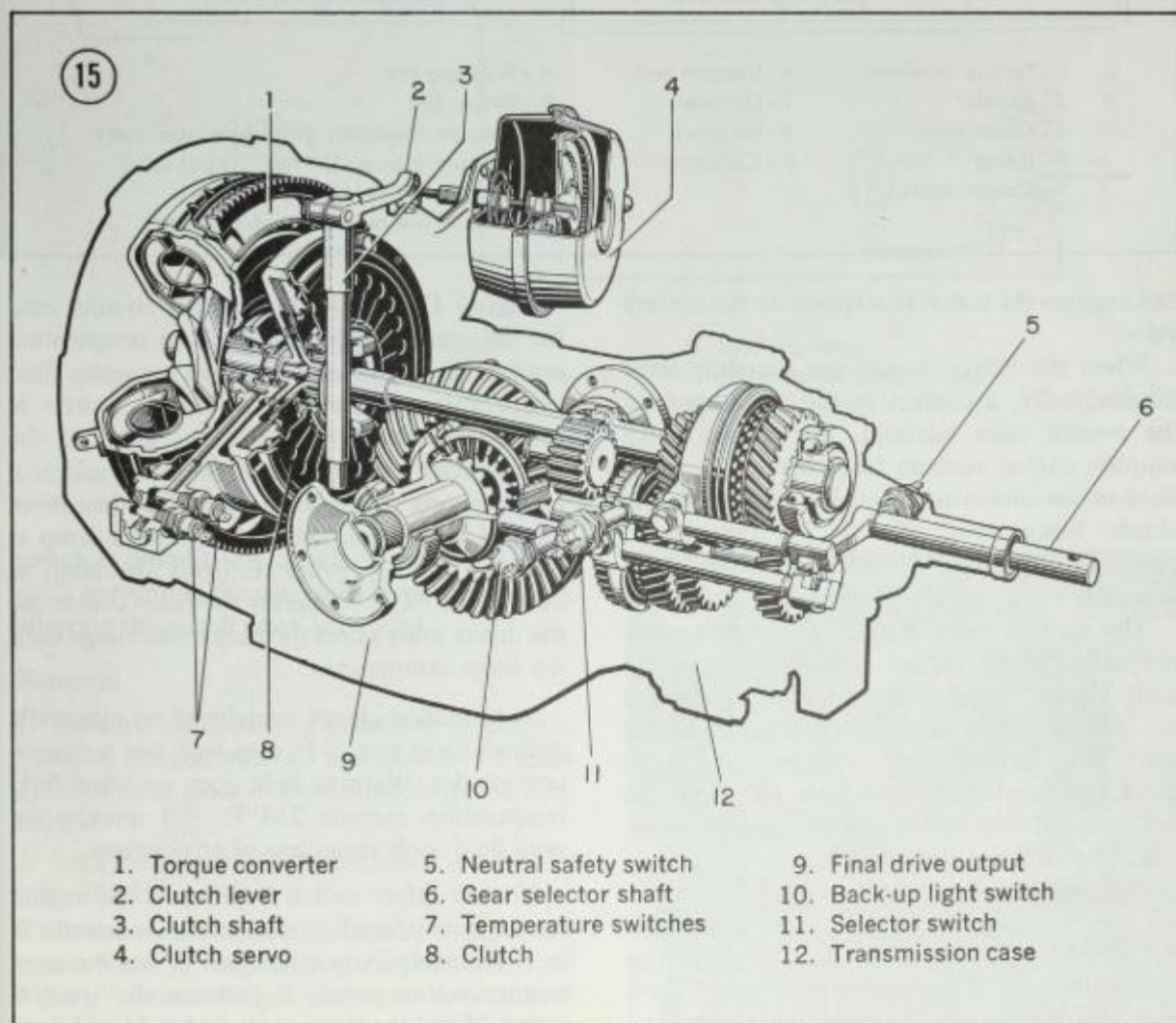
The automatic stick shift has a conventional torque converter to provide smooth application of power over a wide range. But unlike full automatics, the automatic stick shift requires a mechanical clutch to interrupt power flow for gear changes. Gear changes are entirely manual, not automatic.

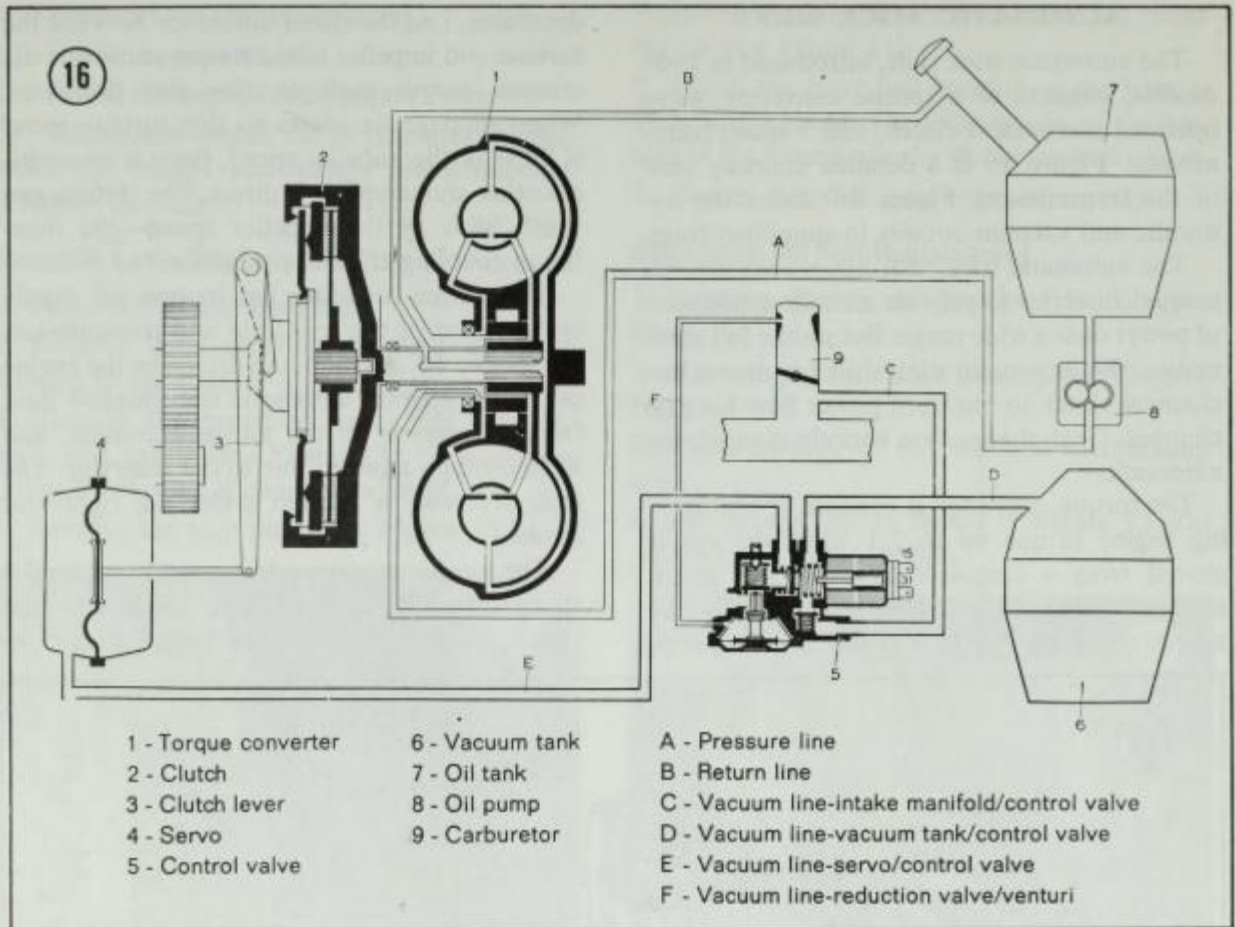
The torque converter is capable of multiplying engine torque up to 2:1 when the car is moved from a complete stop. At this point, torque is maximum and slippage within the torque converter is also maximum. As slippage

decreases, i.e., the speed difference between the turbine and impeller in the torque converter decreases, torque multiplication also decreases. When slippage decreases so that turbine speed is 84% of the impeller speed, there is no multiplication and coupling is direct. The turbine can reach 96% of the impeller speed—the maximum coupling efficiency possible.

The torque converter has its own oil supply independent of the rear axle and transmission. See Figure 16. An oil pump driven by the engine oil pump delivers automatic transmission fluid from a reservoir to the torque converter, and back through a return line to the reservoir. The fluid reservoir is located under the right rear fender.

The torque converter drives a conventional 3 speed transmission through a single dry disc clutch. A vacuum operated servo disengages





and engages the clutch in response to the control valve.

When the driver moves the gearshift lever longitudinally, a contact in the lever operates the control valve solenoid. The control valve supplies engine vacuum from the intake manifold to the clutch servo, which disengages the clutch. Since power flow is interrupted, the driver can continue to move the gearshift and manually select the desired gear.

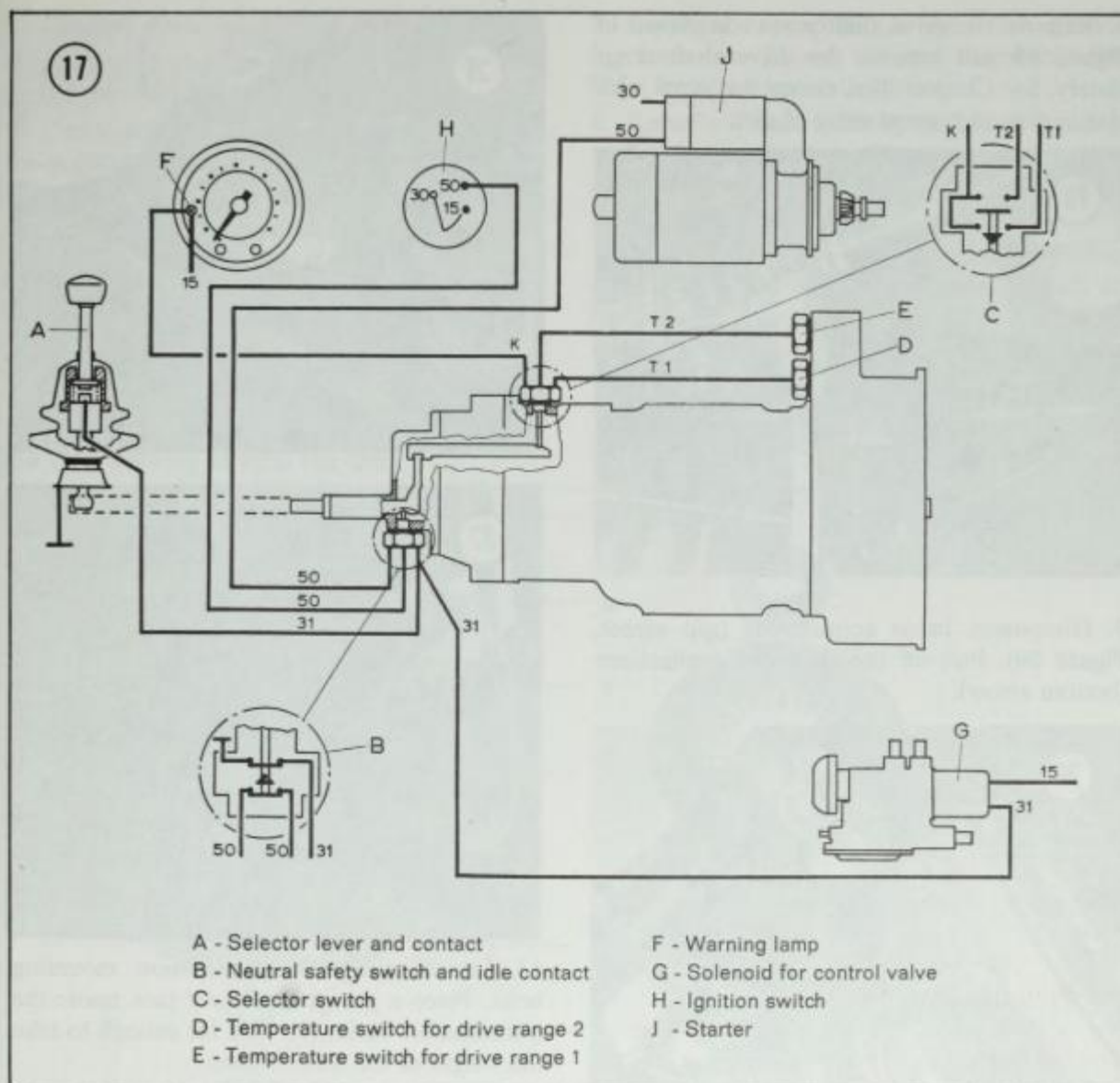
The control valve engages the clutch automatically after an interval, determined by engine load. Vacuum line F between the carburetor and the control valve senses variations in engine load. The control valve engages the clutch quickly during large engine loads (acceleration) and more slowly and smoothly for light loads (deceleration, and downshifting).

The control valve is located on the left side of the engine compartment. A vacuum tank under the left rear fender connects to the control valve and stores sufficient vacuum to permit 5 or 6 gear changes regardless of engine vacuum.

Figure 17 shows the electrical circuits used for the automatic stick shift. Two temperature senders (D & E) monitor torque converter fluid temperature. Temperature selector switch K connects sender D to a warning lamp on the speedometer face when drive range 2 is selected, and connects sender E to the lamp when drive range 1 is selected. Switch D lights the lamp at 257°F (125°C); switch E lights the lamp at 284°F (140°C). Whenever the lamp comes on, the driver must select the next lower range until the lamp extinguishes.

A simplified circuit introduced on automatic stick shifts in late 1971 uses only one temperature sender. Warning light goes on when fluid temperature exceeds 284°F, and remains on until fluid cools regardless of drive range.

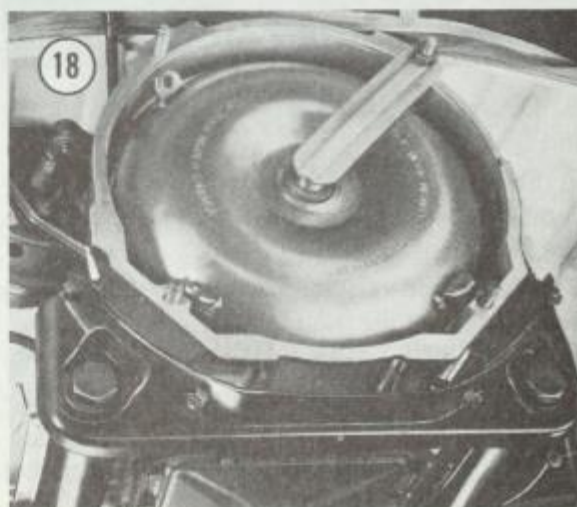
Neutral safety switch B prevents the engine starter from operating unless the gear selector is in N (neutral). Any other gear opens the connection within switch B between the ignition switch H and the starter solenoid J. In addition,



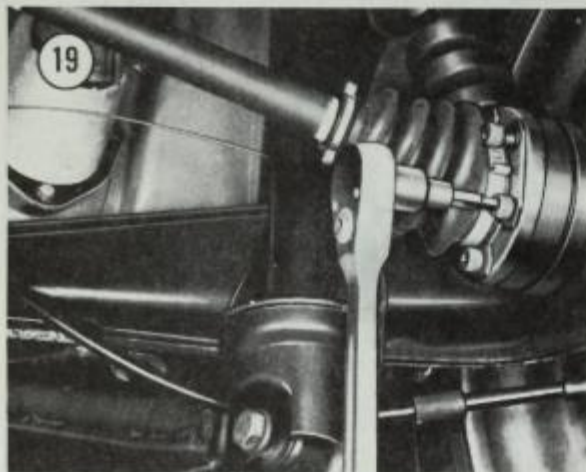
switch B grounds the clutch control valve solenoid, preventing the gear shift lever switch from affecting the clutch when in neutral.

Removal

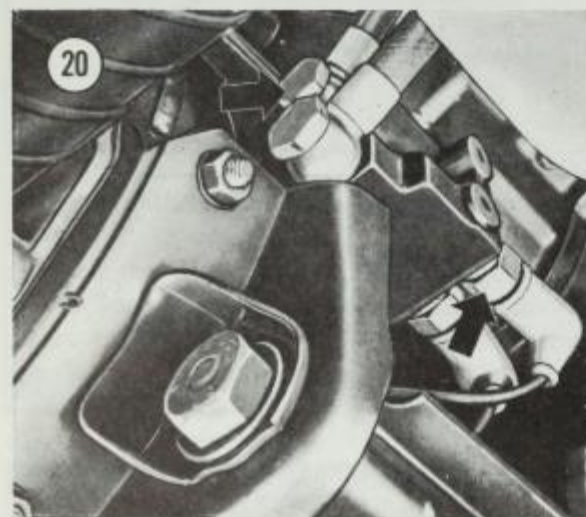
1. Remove the engine as described in Chapter Four. A retainer such as that shown in Figure 18 must be in place or the torque converter may fall out.
2. Jack the car up on jackstands and remove the rear wheels.
3. Remove the rear seat cushion and inspection cover. Remove the shift rod coupling bolt. See Figure 7. Move the gearshift lever to withdraw the coupling from the transmission shift rod.



4. Remove the drive shaft screws as shown in **Figure 19** and remove the drive shaft completely. See Chapter Ten. Cover the joints with plastic caps to prevent entry of dirt.



5. Disconnect banjo connections (top arrow, **Figure 20**). Pull off the electrical connections (bottom arrow).



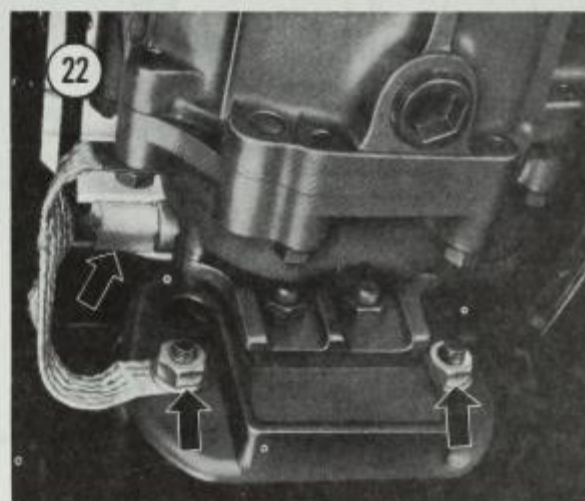
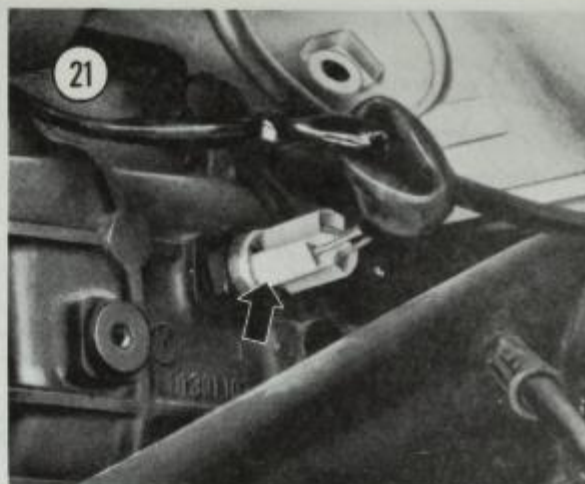
6. Disconnect starter cable connections shown in Figure 5.

7. Slide back the rubber cover and pull off the 3-pin temperature selector switch plug. See **Figure 21**.

8. Disconnect vacuum hose clip on the clutch servo and pull the hose off.

9. Pull back the rubber cover and pull off the 3-pin neutral safety switch plug (top arrow, **Figure 22**).

10. Remove nuts on front transmission mount (bottom arrows, **Figure 22**).



11. Loosen the rear transmission mounting bolts. Place a garage-type floor jack under the transmission. Raise the jack far enough to take the weight of the transmission.

12. Remove the rear mounting bolts, lower the transmission, and withdraw it completely.

Installation

1. Raise the transmission into place and tighten the front mounting nuts.

2. Grease the rear mounting bolts. Install and tighten them.

3. Connect clutch servo vacuum hose and tighten the clip.

4. Connect the banjo fittings. Use washers on each side of the banjo.

5. Connect the 3-pin neutral safety switch plug (see **Figure 22**).

6. Connect the 3-pin temperature selector switch plug (see **Figure 21**).

7. Connect starter cables (see Figure 5).
8. Remove protective covers from joints and install the drive shafts.
9. Connect the gearshift coupling. Ensure that the pointed end of the securing bolt fits fully in the rod recess. Lock the bolt securely with wire.
10. Check engagement of each gear.

Clutch Removal

Refer to **Figure 23** for the following procedure.

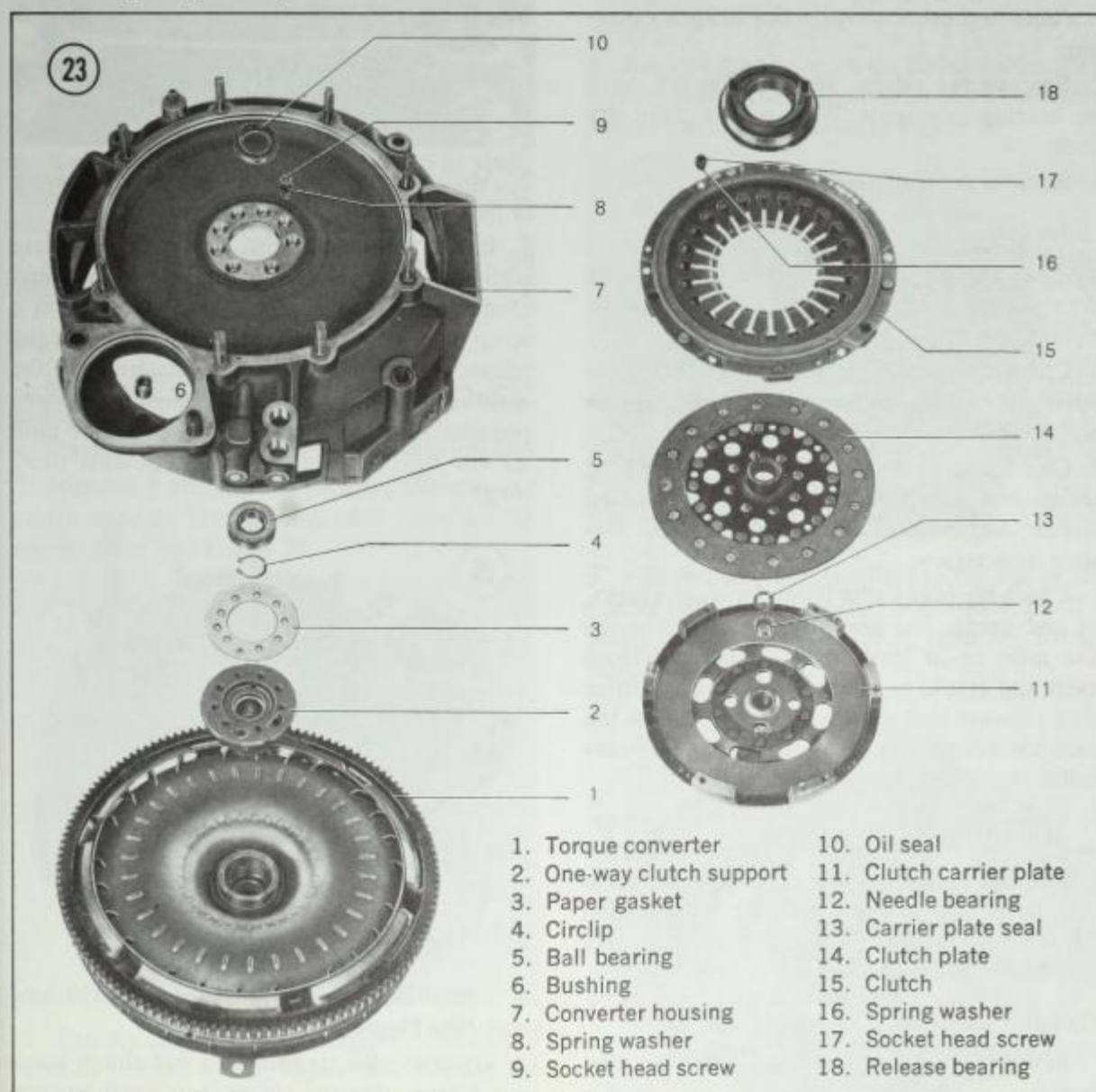
1. Remove the transaxle as described earlier.
2. Remove the torque converter and close off the shaft opening to keep out dirt.

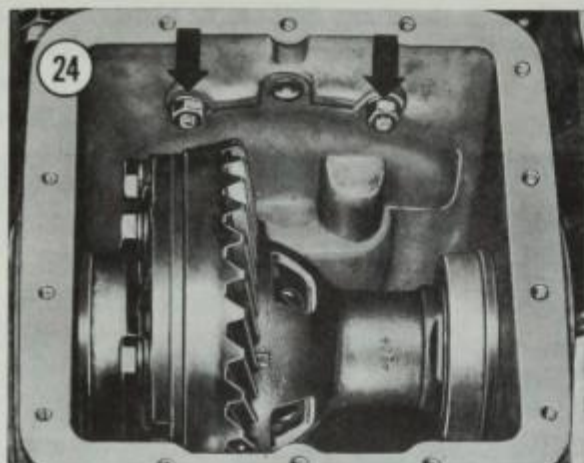
3. Loosen the clamp bolt on the clutch operating lever (see Figure 15) and disconnect the lever from the transmission.

4. Remove 8 nuts securing the clutch housing to the transmission case. Two nuts are accessible only after removing the bottom cover. See **Figure 24**.

5. Separate the clutch housing and transmission case. Turn the clutch operating lever shaft so the jaws disengage from the release bearing. Remove both lower engine mounting bolts from the clutch housing.

6. Remove all 12 point 8mm bolts securing the clutch pressure plate to the clutch housing.





Loosen diagonally opposite bolts a few turns at a time to prevent warpage due to spring pressure.

7. Remove the release bearing. Do not wash the bearing in solvent. Wipe with a clean dry cloth.

8. Remove the clutch disc.

Clutch Inspection

1. Clean the clutch plate carrier and pressure plate in non-petroleum base cleaner such as trichloroethylene.

2. Check the friction surface of the clutch plate carrier for cracks and grooves. If worn, replace as described in a later procedure.

3. Check the pressure plate for cracked or broken spring fingers, cracked or scored friction surface, and evidence of heat (bluish tint). Replace if necessary.

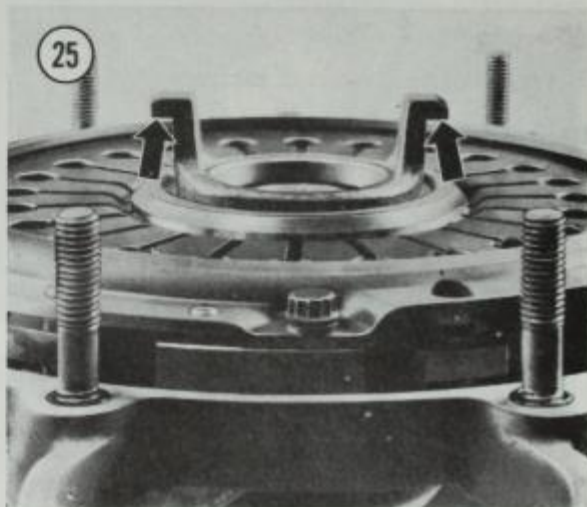
4. Check the clutch disc lining for wear, cracks, oil and burns. The assembled thickness of the disc must be at least 0.36". Check for loose rivets and cracks in the spring leaves or carrier plate. Ensure that the disc slides freely on the transmission mainshaft spline without excessive radial play. Replace the disc if necessary.

5. Check the release bearing for noise or excessive wear. It's good practice to replace an inexpensive part like this, regardless of condition, to prevent having to tear the transmission down again. If other clutch parts are worn, it's very likely the release bearing is also worn.

Clutch Installation

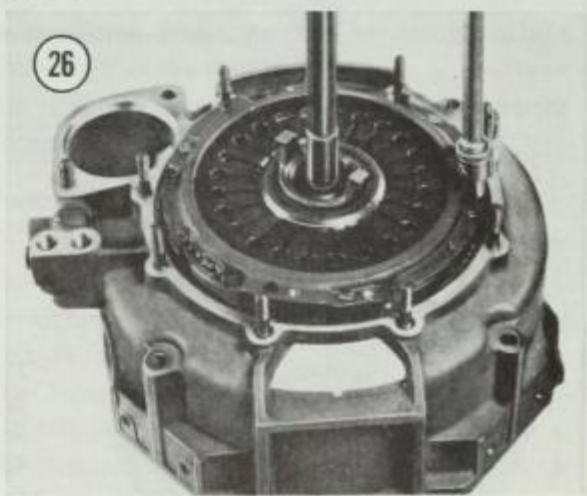
Refer to Figure 23 for the following procedure.

1. Lubricate the release bearing guide on the transmission case and both lugs of the release bearing (see **Figure 25**) with lithium grease. Insert the bearing into the clutch pressure plate.



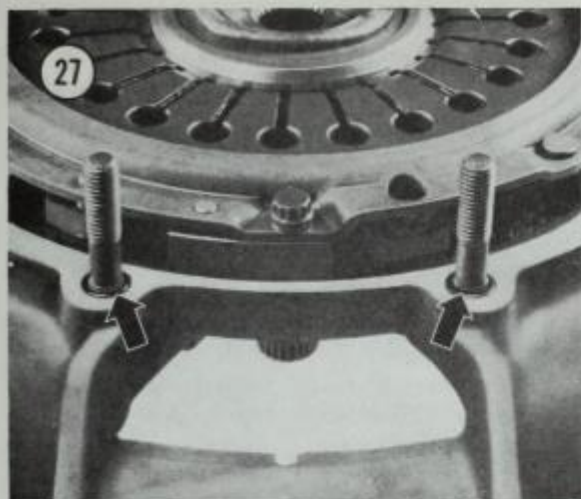
2. Apply lithium grease to the needle bearing in the clutch carrier plate.

3. Install the clutch disc, and pressure plate with release bearing, into the clutch housing. Center the clutch disc with a pilot cut from a scrap mainshaft. See **Figure 26**. Ensure that the release bearing is properly centered in the diaphragm spring. Tighten diagonally opposite pressure plate bolts a few turns at a time until all are tight. Torque to 7 foot-pounds (0.97 mkg).



4. Install the lower engine mount bolts with new seals. See **Figure 27**.

5. Assemble the transmission and clutch housing. Ensure that the clutch lever shaft engages



behind the release bearing lugs. Tighten all nuts evenly, a few turns at a time, then torque to 14 foot-pounds (2 mkg).

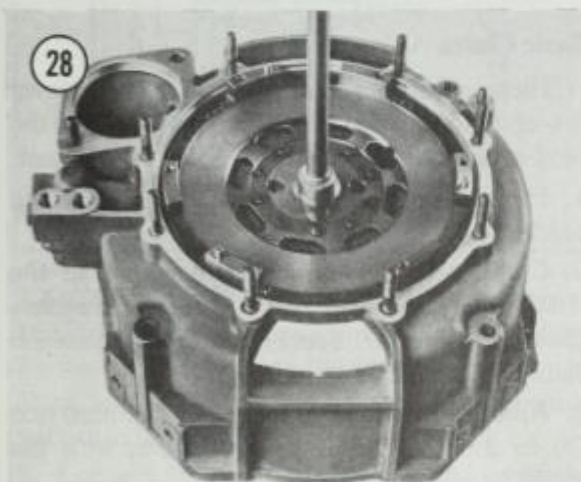
6. Reconnect clutch operating lever to its shaft. Adjust the clutch as described later in this chapter.

7. Install the torque converter. Rotate until the converter seats fully into the turbine shaft.

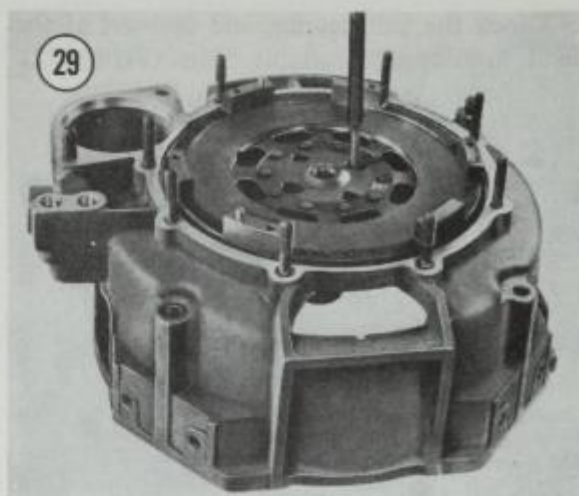
Clutch Carrier Plate Replacement

Refer to Figure 23 for the following procedure.

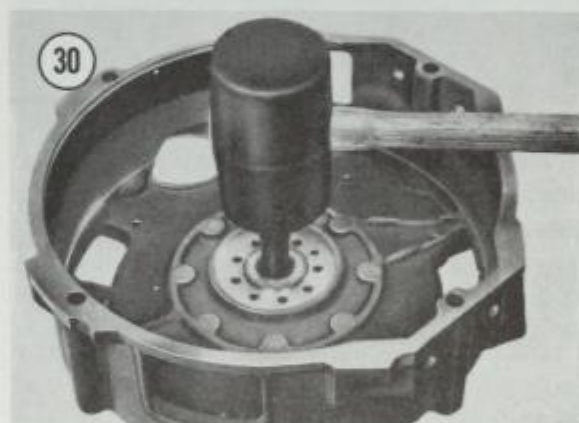
1. Remove the clutch as described previously.
2. Remove 8 allen screws securing the one-way clutch support through any of 4 holes in the carrier plate. See Figure 28.



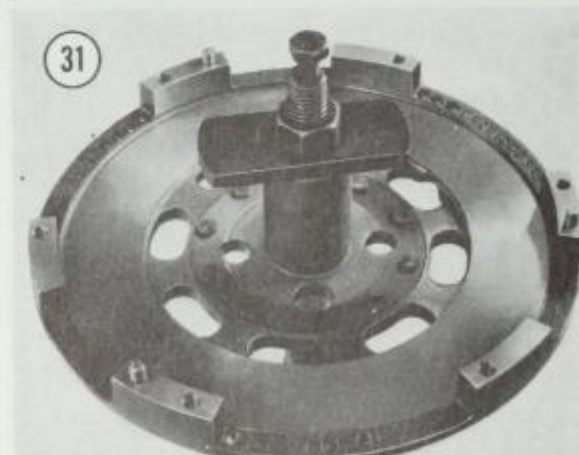
3. Tap the one-way clutch support with a small drift to remove it. See Figure 29. Remove the paper gasket.



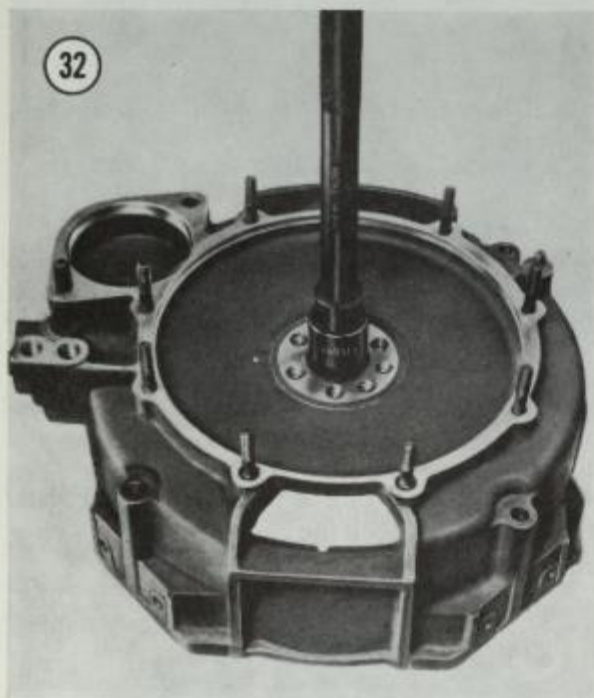
4. Remove the C-ring on the clutch carrier plate turbine shaft. Knock the carrier plate out with a rubber hammer as shown in Figure 30.



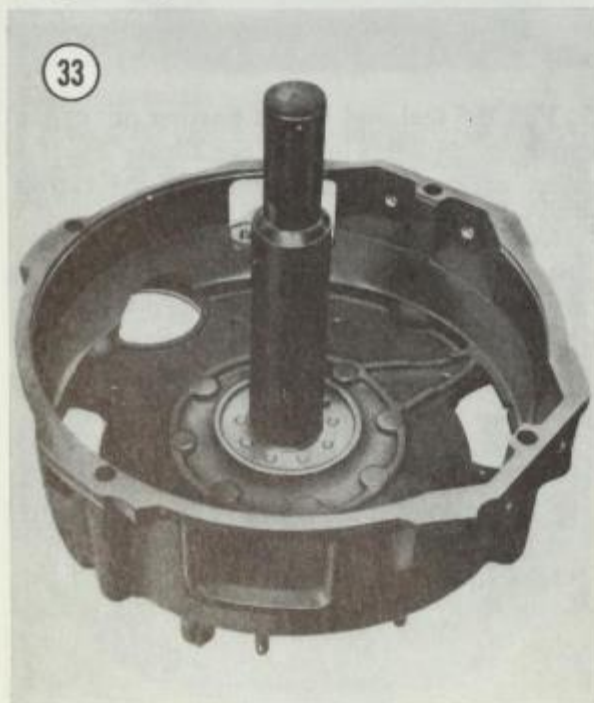
5. Pull the seal and needle bearing out of the carrier plate with a puller. See Figure 31. If a puller cannot be substituted, take the carrier plate to the dealer.



6. Knock the ball bearing and seal out of the clutch housing with suitable drifts. (**Figure 32**).



7. Insert the new ball bearing in the clutch housing with a drift as far as the stop on the housing. See **Figure 33**. Support the bottom of the housing near the bearing on a small sleeve so the studs and housing are not damaged by the pounding.



8. Drive the seal in with the sealing lip towards the torque converter.

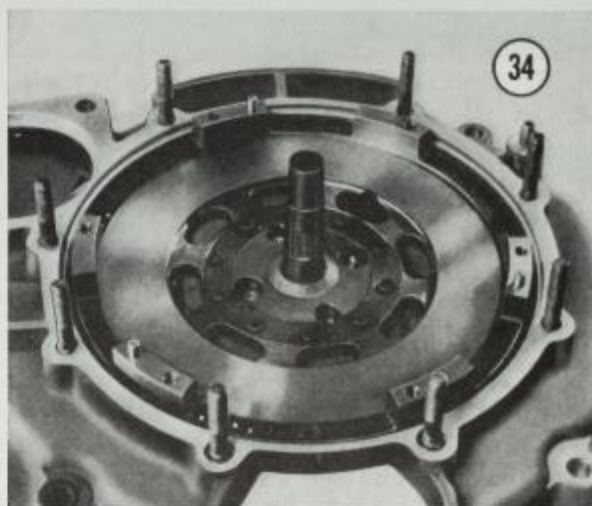
9. Drive the turbine shaft of the carrier plate into the ball bearing and install the C-ring.

10. Using a new paper gasket and O-ring, install the one-way clutch support into the clutch housing. Install the allen screws through holes in the carrier plate.

CAUTION: The paper gasket goes on only one way. The large oil drillings in the one-way clutch support must be clean and not blocked by the gasket.

11. Lubricate the needle bearing with lithium grease and install needle bearing and seal in the carrier plate as shown in **Figure 34**.

12. Reinstall clutch as described earlier.



Basic Clutch Adjustment

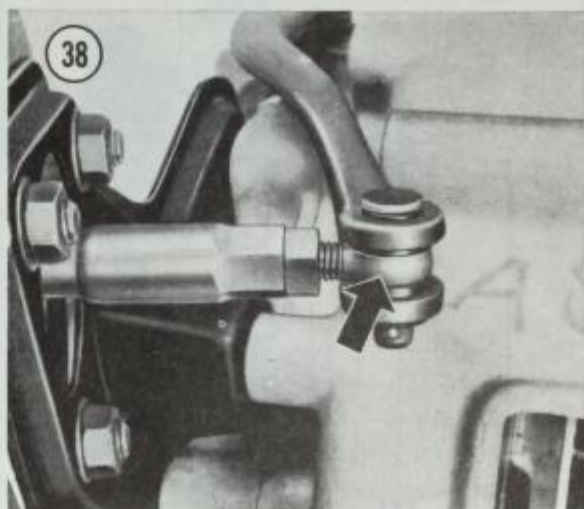
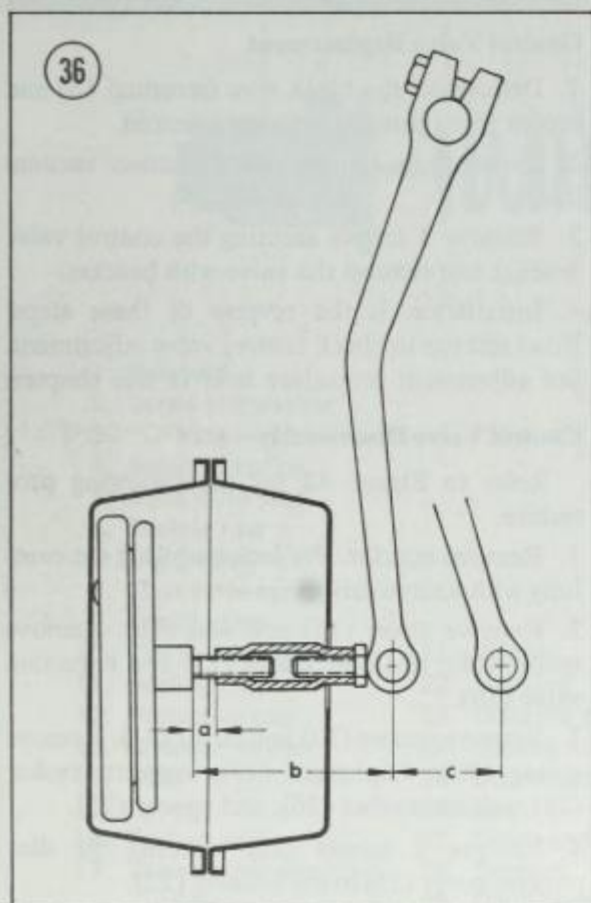
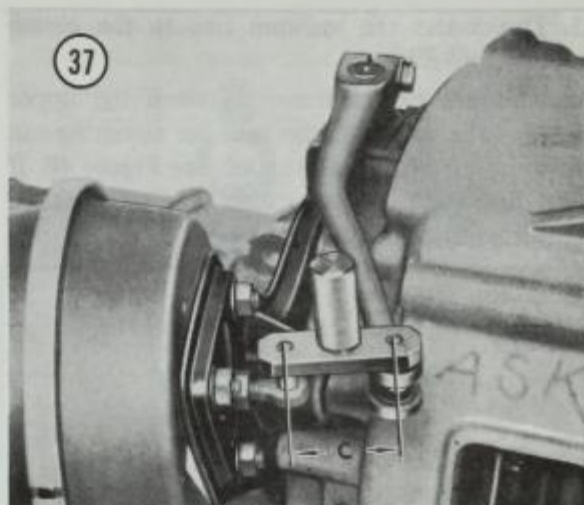
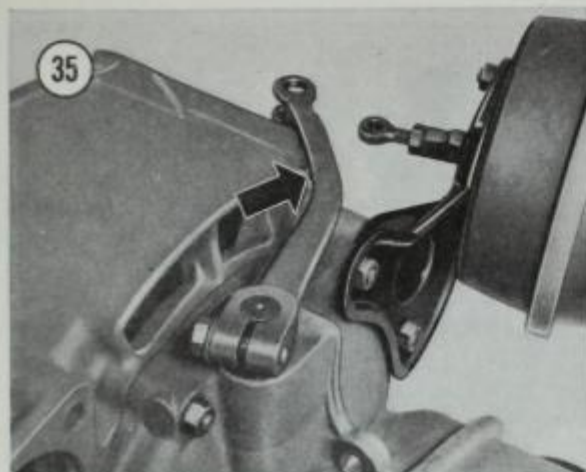
These adjustments are performed whenever the clutch or servo are disassembled. See the next procedure for clutch free play adjustment.

1. Install the clutch servo on the mounting bracket.

2. Connect the clutch operating lever to the clutch operating shaft so that the lever touches the clutch housing. See **Figure 35**. Tighten the clamp bolt slightly.

3. Adjust dimension (a) to 0.335" (8.5mm) and (b) to 3.03" (77mm) in **Figure 36**, with the clutch lever disconnected.

4. Push the servo rod in fully. Turn the operating lever freely on the shaft until dimension (c) in **Figure 36** is reached. This dimension is



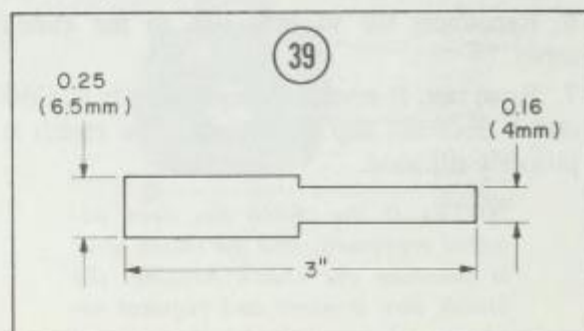
1.54" (40mm). VW uses a special tool shown in **Figure 37**. You can use a steel ruler, measuring between eye centers on the servo rod and operating lever. Tighten the lever in this position with the clamp bolt.

5. Connect the operating lever to the servo rod (see **Figure 38**). Ensure that the plastic sleeves are in place on the lever. Insert the bolt from the top and secure with a new cotter pin.

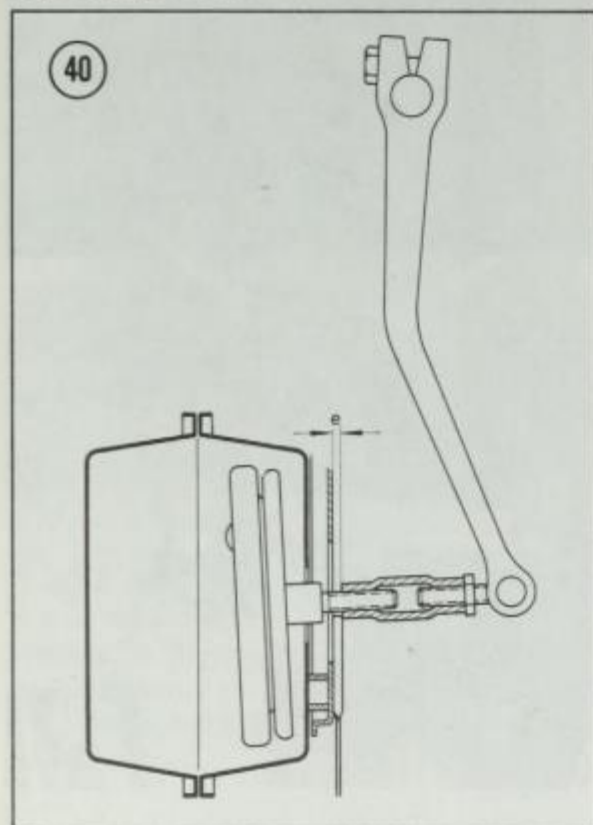
Clutch Play Adjustment

As a result of normal clutch lining wear, clutch play will increase. Every 6000 miles (10,000 km) the play should be checked and adjusted if necessary.

The small tool shown in **Figure 39** is easily made and simplifies both checking and adjusting. Cut from a piece of sheet metal about 0.040" (1mm) thick.

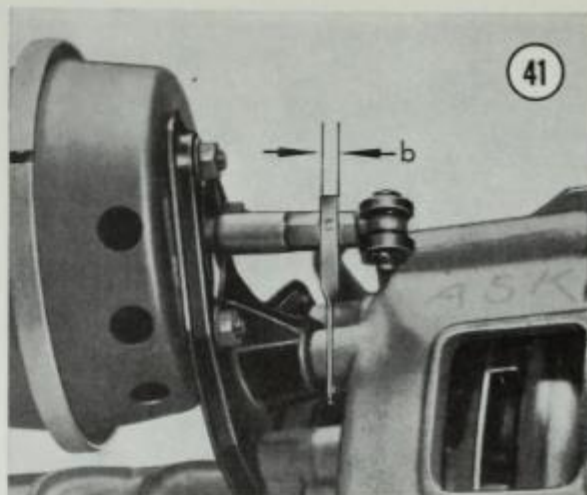


1. Disconnect the vacuum line to the clutch servo.
2. Measure the clearance between the upper edge of the servo bracket and the adjusting nut with the 0.16" end of the tool. See **Figure 40**. If this dimension is greater than 0.16", the clutch requires adjustment.



3. To adjust the clutch, loosen the lock nut on the servo rod slightly. Leave the nut in this position.
4. Turn the adjusting nut **away** from the lock nut about 5 or 5½ turns. Measure dimension (b) with the 0.25" end of the tool. See **Figure 41**.
5. Tighten the lock nut against the adjusting nut.
6. Reconnect the vacuum line to the clutch servo.
7. Road test. If reverse engages silently and the clutch does not slip in 3rd gear, the clutch is properly adjusted.

NOTE: If the clutch has been adjusted previously, and the clutch lever is touching the clutch housing, the clutch disc is worn and requires replacement.



Control Valve Replacement

1. Disconnect the black wire (terminal 15) and brown wire (ground) from the solenoid.
2. Loosen hose clamps and disconnect vacuum lines.
3. Remove 3 screws securing the control valve bracket and remove the valve with bracket.
4. Installation is the reverse of these steps. Road test car to check control valve adjustment. See adjustment procedure later in this chapter.

Control Valve Disassembly

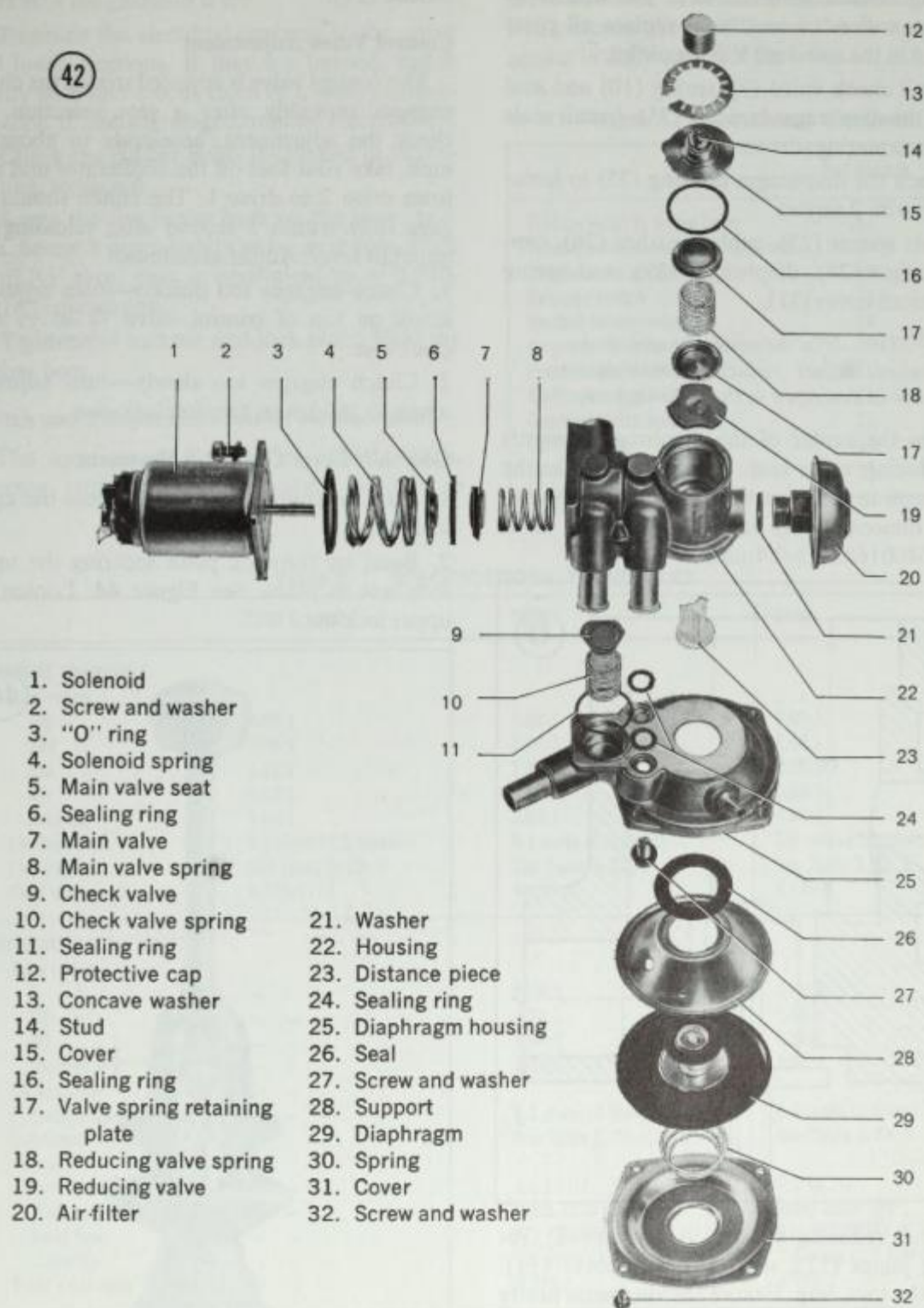
Refer to **Figure 42** for the following procedure.

1. Remove bracket. Pry lock ring (13) out carefully with a screwdriver.
2. Remove cover (15) and seal (16). Remove spring (18), retaining plates (17) and reduction valve (19).
3. Remove screws (32) and cover (31). Remove spring (30), diaphragm (29), support washer (28), rubber washer (26), and spacer (23).
4. Remove 2 screws (27) securing the diaphragm cover (25) to the housing (22).
5. Remove check valve (9), spring (10), and seal (11) from diaphragm housing (25).
6. Remove 4 screws (2) securing the solenoid (1) to the housing (22).
7. Remove the seal (3), spring (4), valve seat (5), seal (6), main valve and spring (8).
8. Unscrew air filter and remove washer (21).

Control Valve Assembly

1. Clean all non-rubber parts in solvent.

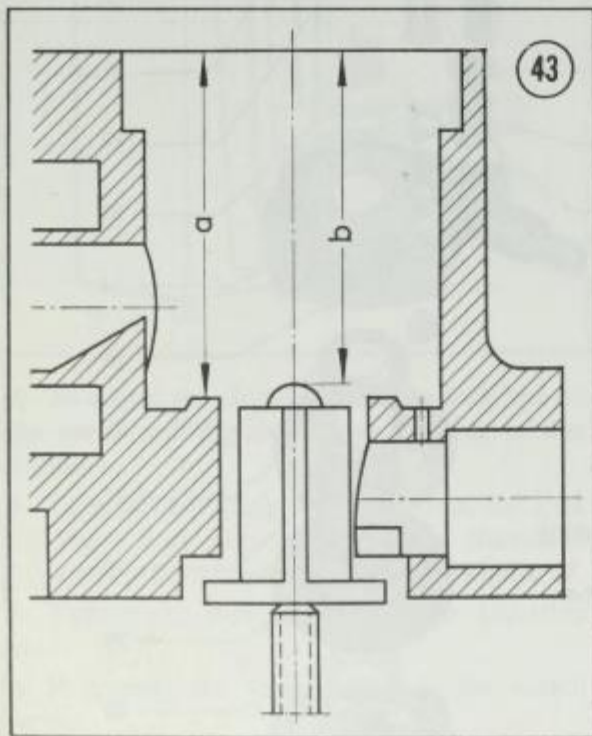
42



2. Check solenoid, valve seats, valves, springs, diaphragms, and seals for wear and deterioration. Regardless of condition, replace all parts included in the standard VW repair kit.
3. Install check valve (9), spring (10) and seal (11) in the diaphragm housing (25). Install seals (24) for mounting screws.
4. Attach the diaphragm housing (25) to housing (22) with 2 screws.
5. Insert spacer (23), rubber washer (26), support washer (28), diaphragm (29), and spring (30). Install cover (31).

NOTE: If a new diaphragm is installed, adjust reducing valve clearance as described in the following step.

6. Press the center of the diaphragm towards the reducing valve seat. Screw the stud in the diaphragm in or out until the difference (X) between dimension (a) and (b) in **Figure 43** is 0.012"-0.016" (0.3-0.4mm).



7. Install reducing valve (19), spring (18), retaining plates (17), seal (16), and cover (15). Insert the lock ring. Ensure the ring seats firmly in the groove.
8. Install items (3-8) in the order shown in **Figure 42**.
9. Install the solenoid with 4 screws.

10. Screw the air filter (20) on, using a new washer (21).

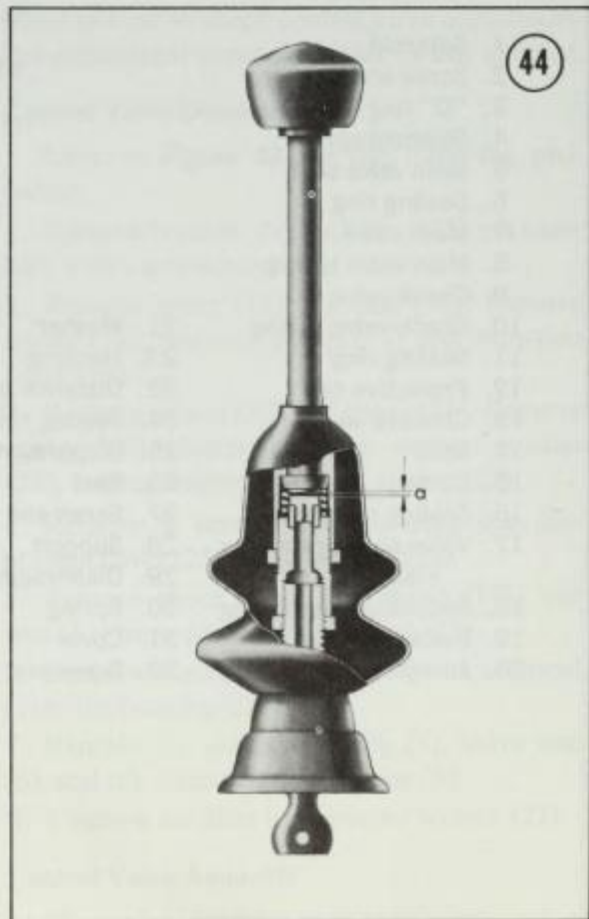
Control Valve Adjustment

The control valve is adjusted so that the clutch engages smoothly after a gear selection. To check the adjustment, accelerate to about 44 mph, take your foot off the accelerator and shift from drive 2 to drive 1. The clutch should engage fully within 1 second after releasing the gearshift lever. Adjust as follows.

1. Clutch engages too quickly—turn adjusting screw on top of control valve $\frac{1}{4}$ to $\frac{1}{2}$ turn clockwise.
2. Clutch engages too slowly—turn adjusting screw $\frac{1}{4}$ to $\frac{1}{2}$ turn counterclockwise.

Gearshift Lever Contact Adjustment

1. Slide the rubber boot up to expose the upper locknut.
2. Bend up the lock plate securing the upper lock nut in place. See **Figure 44**. Loosen the upper lock nut.



3. Unscrew the top sleeve and remove the upper portion of the gearshift lever.
4. Examine the electrical contacts in the upper and lower portions. If they are burned, polish lightly with fine crocus cloth or a relay burnishing tool. If badly damaged, replace the contacts.
5. Check the rubber boot. If cracked or deteriorating, replace it.
6. Screw the top sleeve back on the lower portion. Screw it down lightly as far as it goes. Back it off $\frac{1}{2}$ turn; this is equivalent to a 0.010-0.016" contact gap.
7. Tighten the locknut and lock plate. Refit the rubber boot.

Switch and Temperature Sender Replacement

The location of the neutral safety switch, selector switch, and temperature senders is

clearly shown in Figure 15. To replace any of these switches or senders, disconnect the wires and unscrew the part. Screw the new switch or sender in and reconnect the wires.

Table 1 TIGHTENING TORQUES

	foot-pounds	mkg
Transmission to frame bolts	167	23.0
Transmission mounting nuts (front)	14	2.0
Temperature senders	18	2.5
Selector switch	18	2.5
Neutral safety switch	18	2.5
Converter-to-drive plate bolts	18	2.5
Pressure plate bolts	11	1.5
Clutch housing nuts	11	1.5
One-way clutch bolts	11	1.5
Oil filler plug	14	2.0
Oil drain plug	14	2.0

Table 2 SPECIFICATIONS, TRANSAXLES

	1200 & 1300	1500	1600
MANUAL TRANSAXLE			
Gear ratios			
1st	3.80:1	3.80:1	3.80:1
2nd	2.06:1	2.06:1	2.06:1
3rd	1.32:1	1.32:1	1.26:1
4th	0.89:1	0.89:1	0.88:1
Reverse	3.88:1	3.88:1	3.61:1
Oil Capacity	5.3 pints (2.5 liters)	5.3 pints (2.5 liters)	5.3 pints (2.5 liters)
Lubricant	See Table 3, Ch. 2	See Table 3, Ch. 2	See Table 3, Ch. 2
Final drive ratio	4.375:1	4.125:1	4.125:1
AUTOMATIC STICK SHIFT			
Gear ratios			
L	— — —	2.06:1	2.06:1
D1	— — —	1.26:1	1.26:1
D2	— — —	0.89:1	0.88:1
Reverse	— — —	3.07:1	3.07:1
Oil capacity	— — —		
(except torque converter)	— — —	6.3 pints (3 liters)	6.3 pints (3 liters)
Lubricant	— — —	See Table 3, Ch. 2	See Table 3, Ch. 2
Converter			
Torque ratio	— — —	2:1 to 1:1	2:1 to 1:1
Stall speed	— — —	2000-2250 rpm	2000-2250 rpm
Fluid type	— — —	ATF (DEXRON)	ATF (DEXRON)
Capacity	— — —	7.6 pints (3.6 liters)	7.6 pints (3.6 liters)
Final drive ratio	— — —	4.375:1	4.125:1

CHAPTER TEN

REAR AXLE AND SUSPENSION

The VW Beetle and Karmann Ghia rear suspension changed for the first time with the introduction of the automatic stick shift in 1968. Prior to this, rear suspensions consisted of swing axles which pivoted only at their inner end, i.e., the rear wheels swung vertically in an arc with the transaxle at the center. The rear wheels connect through spring plates to torsion bars. Conventional shocks dampen wheel movement.

Automatic stick shift VW's in 1968, and all VW's from 1969 on have had double-jointed axles. Instead of swinging in an arc, the rear wheels have slight negative camber which increases with load or during cornering. Lateral forces are taken by diagonal trailing arms which connect to the rear wheels and transfer lateral forces directly to the frame. Rear wheels connect to torsion bars through spring plates as on earlier suspensions.

This chapter includes repair or replacement of all rear suspension and rear axle components, except the transaxle which is covered in Chapter Nine. Specifications are at the end of the chapter.

DRIVE SHAFT (SWING AXLE)

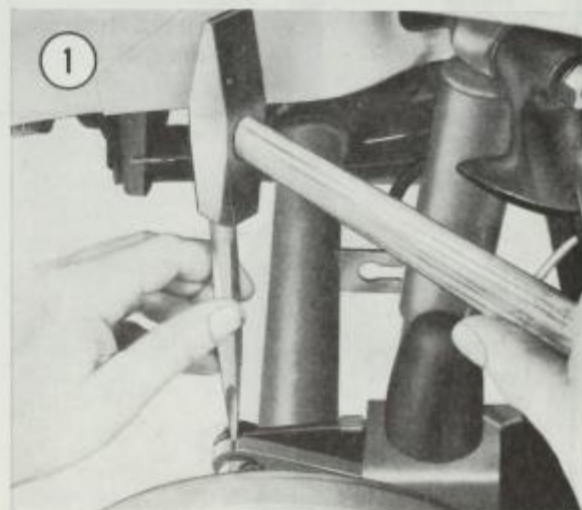
Removal

1. Remove brake drums as described in Chapter Twelve.

2. Disconnect handbrake cable and brake hose from backing plate.

3. Remove bearing cover, backing plate and wheel bearing as described under Wheel Bearing Replacement (swing axles).

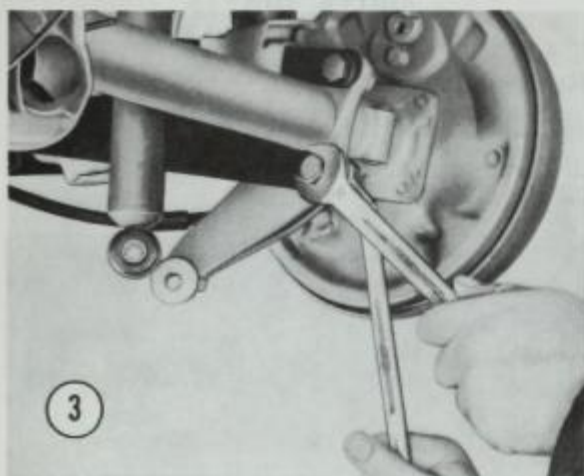
4. Mark spring plate position in relation to the rear axle bearing housing groove. Use a chisel. See **Figure 1**.



5. Disconnect lower end of shock absorber.

6. Remove axle tube retainer nuts as shown in **Figure 2**.

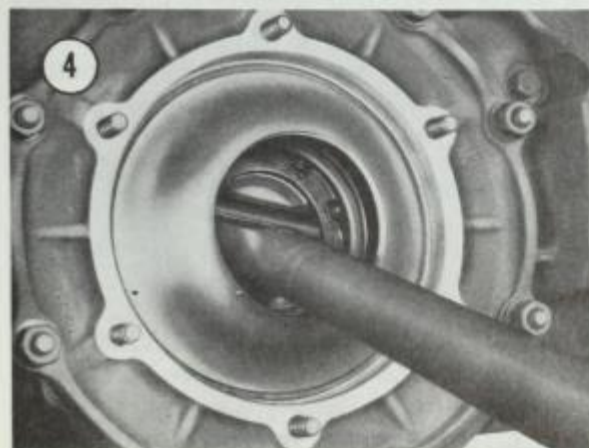
7. Remove bolts securing axle bearing housing to spring plate. See **Figure 3**.



8a. On 1961-1967 axles (to chassis number 117 580 249), pull off axle tube, retainer, gasket, and plastic packing.

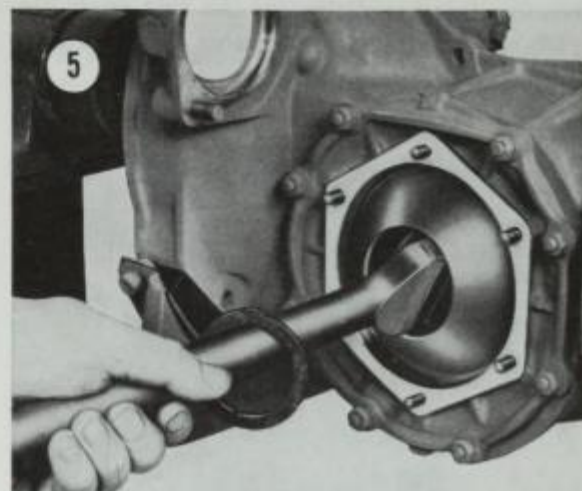
8b. On all axles from chassis number 117 580 250, pull off axle tube, hard paper shims, and O-ring. Count number of shims removed.

9. Remove differential side gear lock ring and thrust washer shown in **Figure 4**.



10. Remove drive shaft. See **Figure 5**.

11. Remove differential side gear.



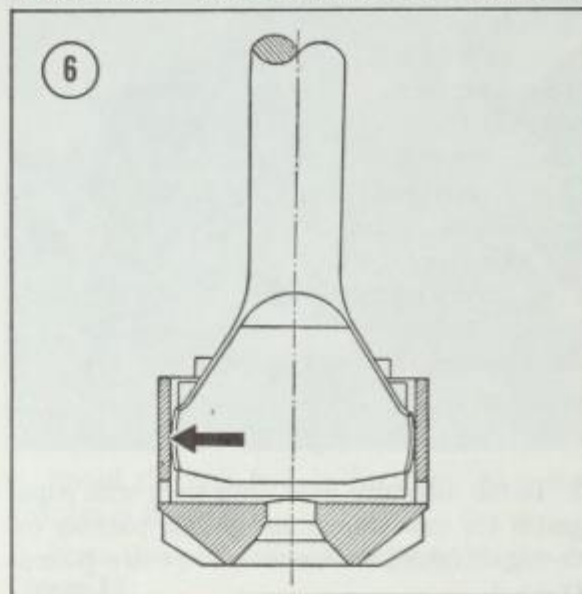
Inspection

1. Clean all parts in solvent. Clean the retainer seat on the final drive cover.

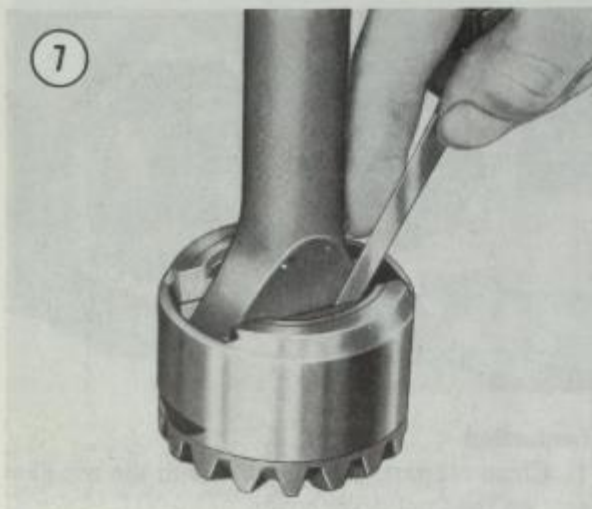
2. Check rubber boot for cuts or deterioration. Replace if necessary with split-type replacement boot.

CAUTION: To install original un-split type, the axle tube and bearing housing must be separated. Do not attempt this as there is considerable chance of damage to the housing.

3. Check drive shaft, side gear and thrust washer for damage or wear. Clearance between rounded end of shaft and side gear should be 0.001-0.004" (0.03-0.1mm). See **Figure 6**.



Clearance between flat portions (see **Figure 7**) should be 0.001-0.010" (0.035-0.244mm). Oversize fulcrum plates for the side gears are available if clearance is excessive. In such cases, consider new standard size parts as well.



Installation

1. Install differential side gear, drive shaft and thrust washer as shown in **Figure 8**. Secure with lock ring.



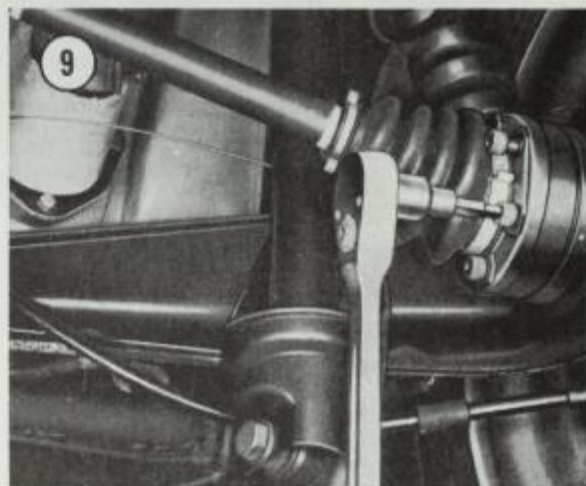
2. Install axle tube over drive shaft with paper gasket (or new shims) and plastic packing (or O-ring). Tighten retainer nuts to 14 foot-pounds (2 mkg).

3. Tighten rubber boot clamps.
4. Bolt bearing housing to spring plate. Align chisel mark with groove and tighten bolts to 80 foot-pounds (11 mkg).
5. Connect lower end of shock absorber.
6. Install wheel bearing as described under Wheel Bearing Replacement.
7. Install backing plate and bearing cover.
8. Connect handbrake cable. Connect brake hose.
9. Install brake drum as described in Chapter Twelve. Bleed and adjust foot brake and hand brake.

DRIVE SHAFTS (DOUBLE JOINT AXLE)

Removal/Installation

1. Raise the car on jackstands.
2. Remove allen bolts at both ends of the drive shaft. See **Figure 9**.

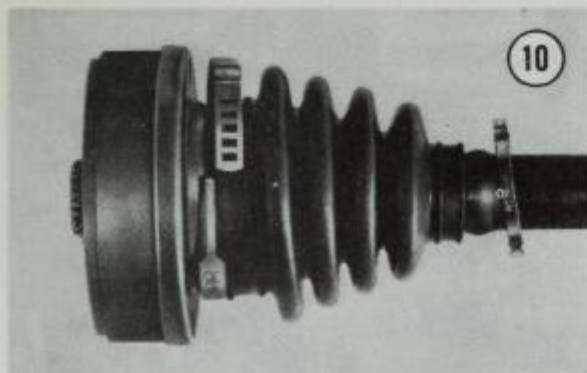


3. Tilt the shaft and remove it.
4. Cover all exposed openings to prevent entry of dirt.
5. Check parts for obvious damage. Constant velocity joints at either end of shaft are described in a later procedure.
6. Installation is the reverse of these steps.

CONSTANT VELOCITY JOINTS (DOUBLE JOINT AXLES)

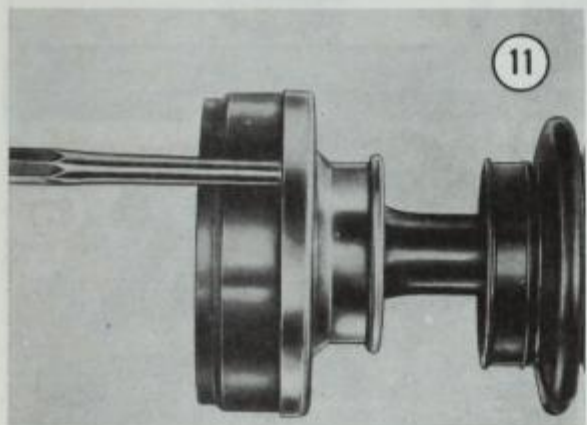
Removal

1. Remove drive shaft as described previously.
2. Loosen rubber boot clamps and slide the boot back. See **Figure 10**.

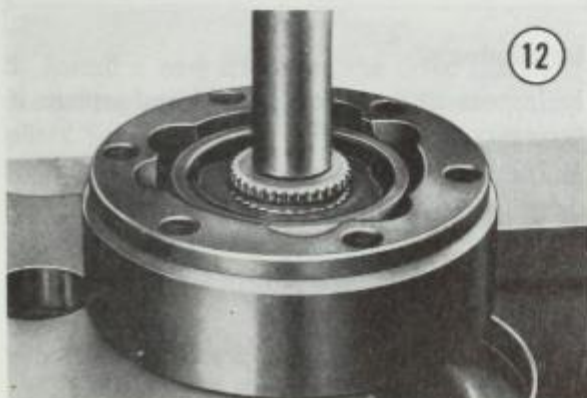


3. Drive metal cap off joint with a drift as shown in **Figure 11**.

NOTE: Do not tilt the ball hub more than 20° after removing the cap or the balls will fall out.



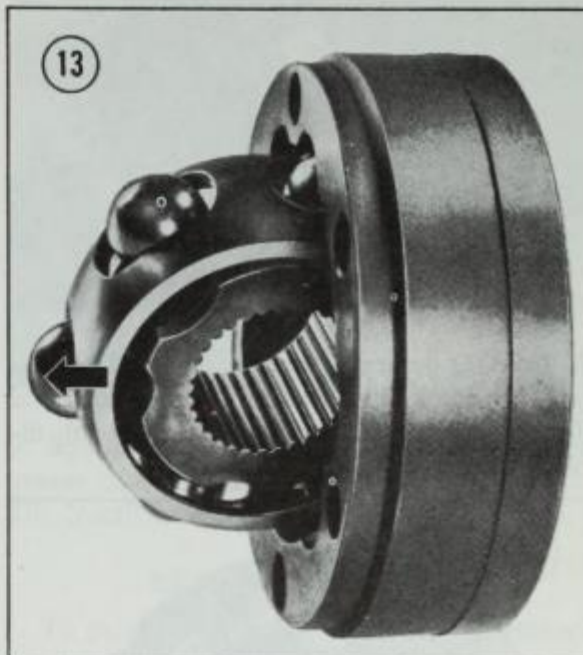
4. Remove circlip from ball hub.
5. Slide outer part with balls onto the ball hub.
6. Press the drive shaft out of the ball hub as shown in **Figure 12**. Support the hub from underneath when doing this.



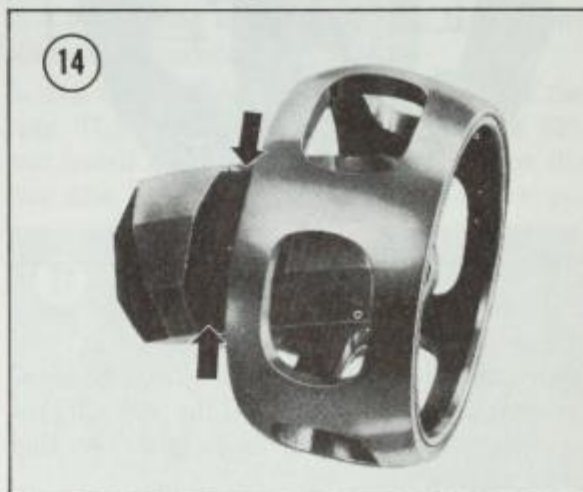
7. Remove the dished washer from the joint.
8. Slide the rubber boot off drive shaft.

Disassembly/Assembly

1. Remove constant velocity joint as described previously.
2. Press ball hub and cage out of the outer ring as shown in **Figure 13**.



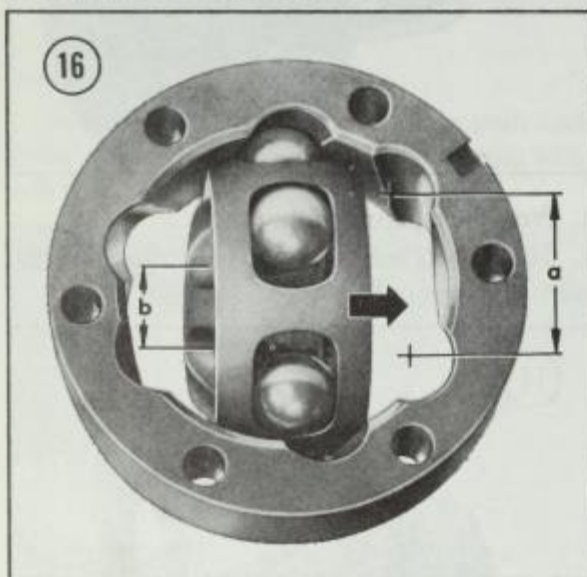
3. Press the balls out of the cage.
4. Tip the ball hub out of the ball cage using the grooves shown in **Figure 14**.



5. Clean all parts in solvent. Check each part for signs of wear or scoring.
6. Install the ball hub in the cage using the grooves in the hub.
7. Press the balls into the cage as shown in **Figure 15**.



8. Hold the outer ring so the large diameter end faces up. Look at the ball groove spacing. Note that the spacing at (a) is wider than at (b), directly opposite. See **Figure 16**.

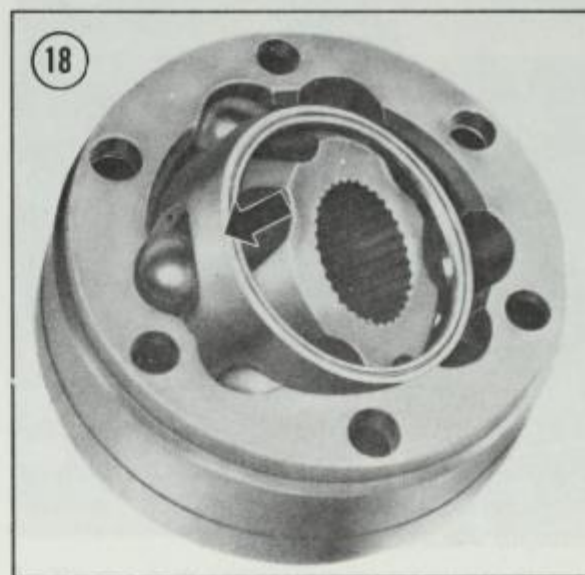
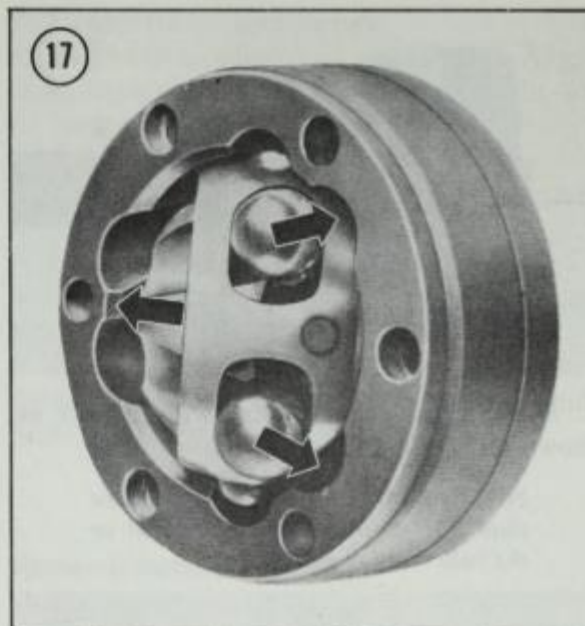


9. Insert the ball hub and cage into the outer ring as shown in **Figure 17**. Ensure that wide spaced balls line up with wide spaced grooves, and that the chamfered end of the hub will face towards the large diameter end of the outer ring when the hub is pivoted.

10. Pivot the ball hub in the hub until the balls fit into their grooves.

11. Press the sage firmly where indicated in **Figure 18** until the hub swings into position.

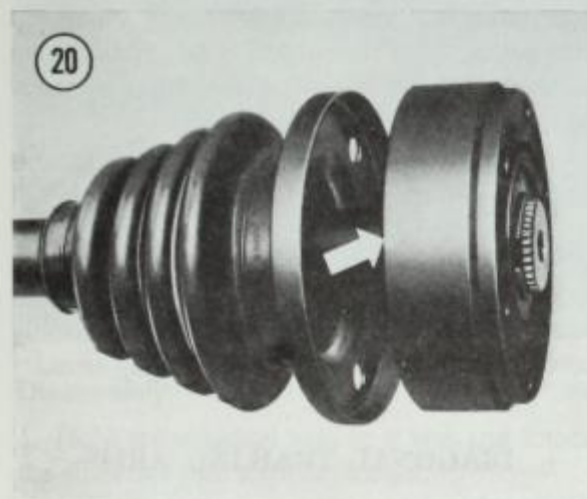
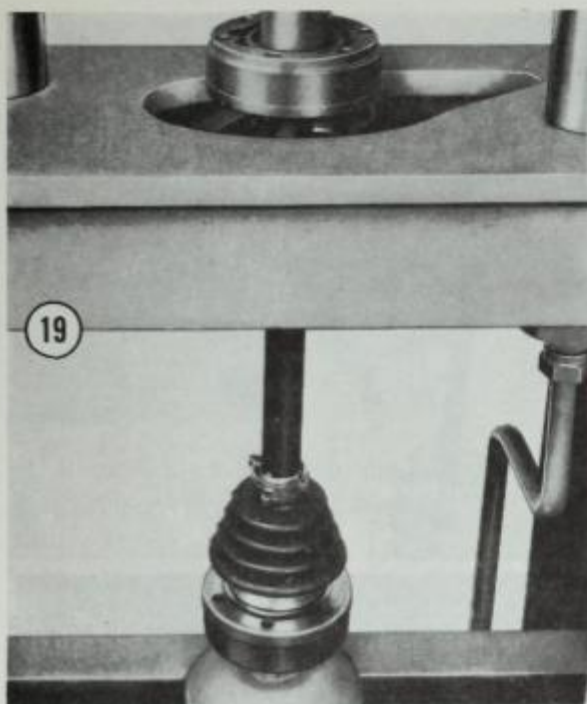
12. Check the joint before installing. It should be possible to move the hub by hand through its full range.



Installation

1. Inspect all parts for damage and replace if necessary.
2. Install rubber boot over drive shaft. Make sure that the boot is not damaged by the splined end.
3. Slide the metal cap, then the dish washer, over the drive shaft.
4. With a hydraulic press, press the joint onto the drive shaft. See **Figure 19**.

NOTE: The large diameter end (see arrow, **FIGURE 20**) faces the metal cap.



5. Install a new circlip on the drive shaft and press it tightly into its groove with water pump pliers. See **Figure 21**.

6. Pack about 2 ounces (60 grams) of lithium grease (with molybdenum disulphite additive) between outer part of joint and metal cap. Do not get any grease on contact surfaces between the cap, joint or rubber boot. Pack another ounce (30 grams) into the end of the joint which faces the wheel.

7. Tap the metal cap into place over the joint.

8. Slide the rubber boot over the metal cap. Tighten both clamps securing the boot.



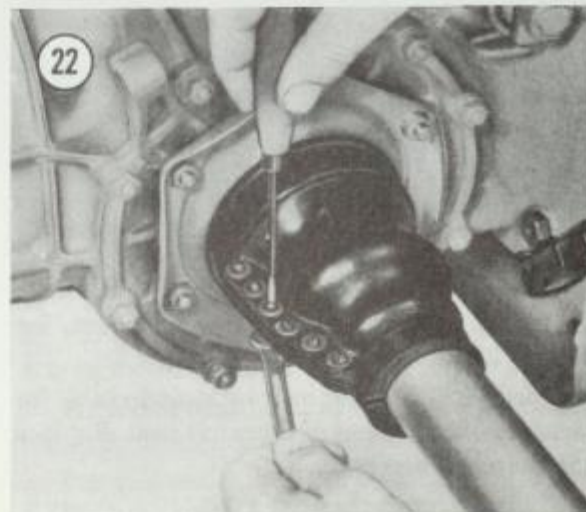
9. Squeeze the rubber boot by hand to force grease into the rear of the joint.

10. Install drive shaft as described previously.

REAR AXLE BOOTS

To permit boot replacement without removing drive shafts, a split boot is available.

1. Remove retaining clamps on boot.
2. Cut the old boot off.
3. Clean areas the boot had covered.
4. Coat joining faces of the split boot lightly with sealing compound.
5. Install the boot with the split towards the rear. Tighten the boot screws (see **Figure 22**), and install new clamps with a full load on the rear axle. Do not overtighten screws or clamps.



OIL SEAL REPLACEMENT

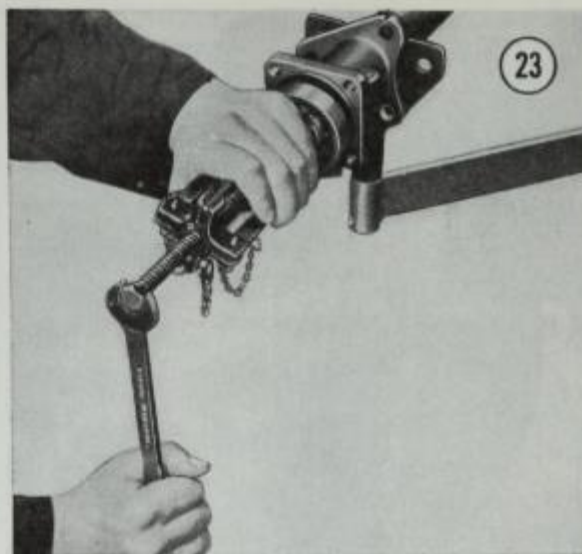
1. Remove brake drum as described in Chapter Twelve.
2. Clean bearing cover and backing plate carefully with solvent. Do not get grease, oil or solvent on brake shoes. If necessary, remove them to prevent damage.
3. Remove bolts securing bearing cover and remove the cover.
- 4a. On swing axles only, remove spacer, rubber O-rings, and washer.
- 4b. On double joint axles, remove spacer and rubber O-ring.
5. Pry the oil seal out of the bearing cover. Do not try to pound it out from the outer end or the oil slinger will be damaged. Remove the oil slinger.
6. Fit the oil slinger in the bearing cover.
7. Install the oil seal with the open end (spring visible) towards the transmission. Tap it in evenly until it fits against the shoulder near the bottom of the cover.
8. Slide new large rubber O-ring over the outer bearing race.
9. On swing axles only, slide the washer and a new small rubber O-ring on the shaft next to the inner bearing race.
10. Slide the spacer on the shaft.
11. Install bearing cover with a new paper gasket. Tighten cover bolts to 40 foot-pounds (5.5 mkg).

WHEEL BEARINGS

Replacement (Swing Axles)

This procedure requires a special bearing puller which grips between the inner and outer bearing races. If this type puller is not available and cannot be improvised, take the job to a VW dealer for replacement.

1. Perform steps 1-4 of the Oil Seal Replacement procedure.
2. Remove bearing with the special puller. See **Figure 23**.
3. Clean ball bearing in solvent and check for wear, scoring or signs of excessive heat. Replace the bearing if necessary.
4. Slide spacer on the drive shaft.



5. Slide the bearing into place with the nylon cover toward the transmission and the numbers facing out. Tap the inner race, working around the drive shaft evenly, to seat the bearing. When the outer race contacts the backing plate, tap around the outer race as well. Continue working around both races until the bearing is firmly seated.
6. Perform steps 8-11 of the Oil Seal Replacement procedure.

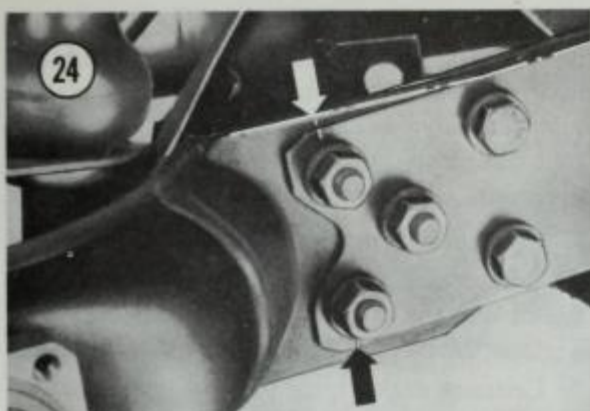
Replacement (Double Joint Axles)

Wheel bearings are located in the diagonal trailing arms. For replacement, see disassembly and assembly procedure for the trailing arms.

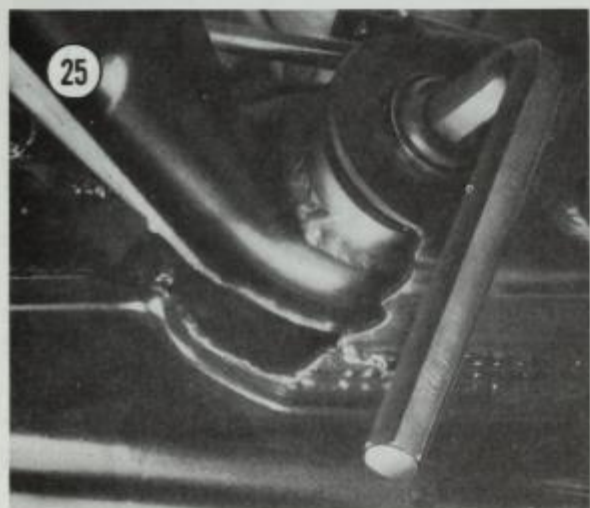
DIAGONAL TRAILING ARMS

Removal

1. Remove the brake drum as described in Chapter Twelve.
2. Remove drive shaft and cover exposed constant velocity joint to prevent entry of dirt.
3. Disconnect brake hose and handbrake cable from the brake backing plate.
4. Remove bolts securing bearing cover. Remove the bearing cover and backing plate.
5. Mark position of spring plate in relation to diagonal arm with a chisel. See **Figure 24**.
6. Disconnect lower end of shock absorber.
7. Remove bolts securing spring plate to diagonal arm.

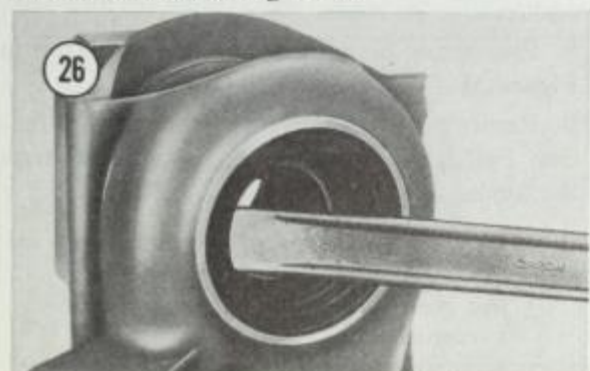


8. Remove allen bolt securing diagonal arm to bracket (see **Figure 25**) and remove the diagonal arm.



Disassembly

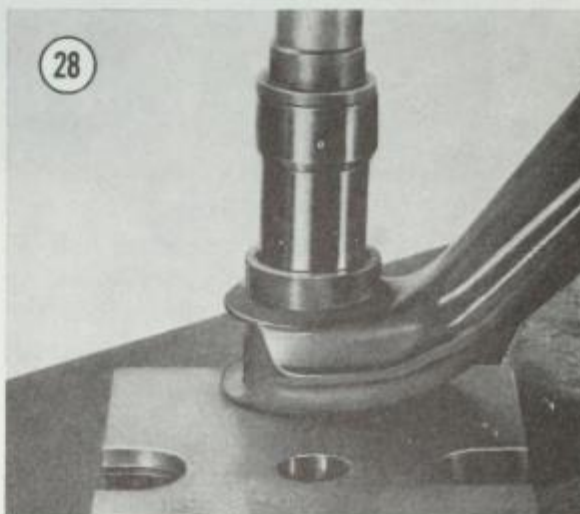
1. Hold the diagonal arm in a vise and knock the shaft out with a rubber mallet.
2. Remove the spacer ring, bearing inner ring and spacer from the opening facing the wheel.
3. Knock the outer ring out with a drift, and pry the oil seal out. See **Figure 26**.



4. Remove the large circlip (see **Figure 27**) and pull the bearing out.

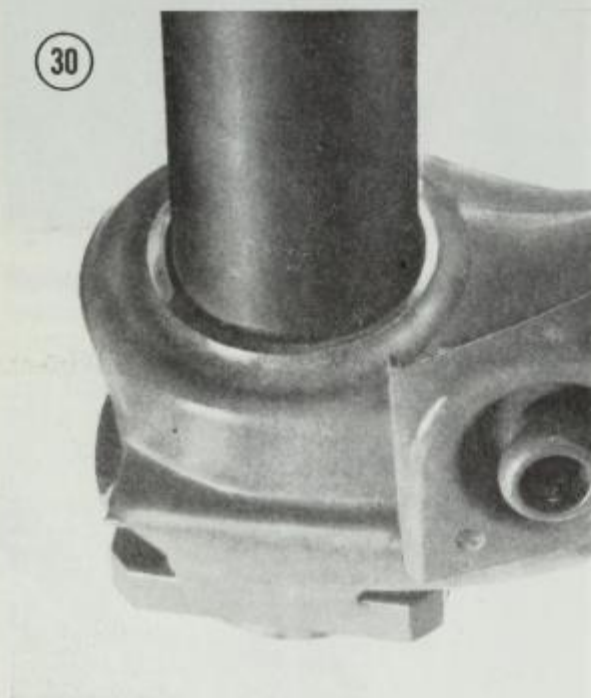
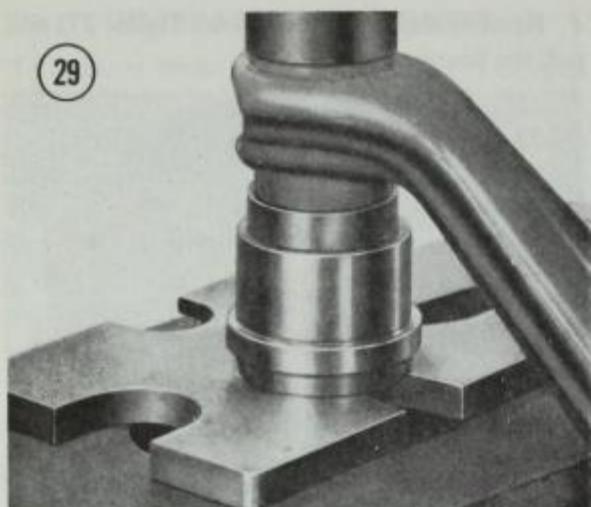


5. Press the rubber bushing out of the diagonal arm. See **Figure 28**.
6. Pry the oil seal out of the bearing cover.



Assembly

1. Press new rubber bushing into the diagonal arm as shown in **Figure 29**.
2. Press ball bearing in as far as it will go, and install the circlip. See **Figure 30**.
3. Press oil seal in diagonal arm.
4. Pack the bearing housing in arm with lithium



grease until the spacer sleeve will just fit. Usually about 2 ounces (60 grams) are required.

5. Press the outer roller bearing ring in.
6. Press shaft with inner spacer ring into the bearing.
7. Press inner roller bearing ring in. Support the shaft flange during this step.
8. Press the oil seal into the bearing cover.

Installation

1. Secure diagonal arm to frame bracket with allen bolt. Lock the bolt by peening the bracket collar into a bolt head groove with a dull chisel.

2. Connect diagonal arm to spring plate. Align chisel marks and tighten to 87 foot-pounds (12 mkg). If a new diagonal arm or spring plate is installed, align as close as possible by eye, then take the car to a VW dealer for final adjustment on special alignment equipment.

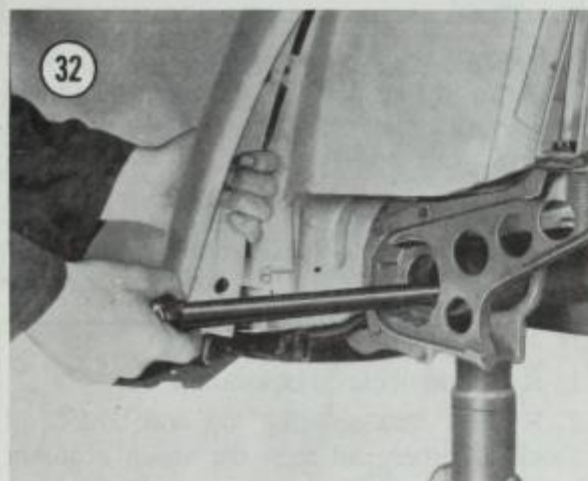
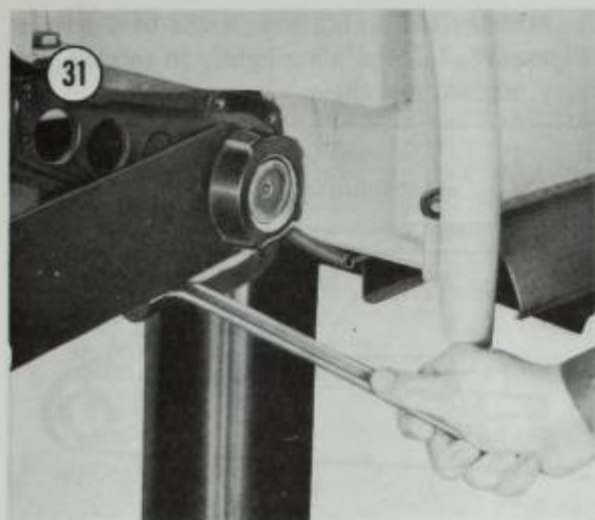
3. Connect lower end of shock absorber.
4. Grease bearing cover O-ring lightly and install it with the backing plate and bearing cover. Tighten the bolts to 36 foot-pounds (5 mkg).
5. Connect brake hose and handbrake cable. Adjust the handbrake. See Chapter Twelve.
6. Install drive shaft as described previously.
7. Install brake drums as described in Chapter Twelve.

TORSION BARS

Removal

1. Raise the car on jackstands and remove the rear wheels.
2. On double joint axles, remove the drive shaft.
3. Disconnect handbrake cable at the handbrake operating lever and pull them towards the rear slightly.
- 4a. On swing axles, mark the spring plate position in relation to the rear axle bearing housing groove with a chisel, as shown in Figure 1.
- 4b. On double joint axles, mark spring plate and trailing arm with a chisel as shown in Figure 24.
5. Disconnect lower end of shock absorber.
6. Remove bolts securing spring plate to axle shaft housing (swing axles) or trailing arm (double joint axles). Tie housing or arm up.
7. Remove bolts securing spring plate hub cover and remove the cover.
8. Pull spring plate off lower stop as shown in Figure 31. Pull spring plate off torsion bar.
9. Remove 5 or 6 bolts from front edge of fender. Pull fender **carefully** aside and withdraw the torsion bar. See Figure 32.

CAUTION: A protective paint covers the torsion bars. Do not nick or scratch this paint. Even slight damage leads to corrosion and eventual fatigue fractures. Touch up with paint, if necessary.



Installation

1. Grease splines on torsion bar and insert it.

NOTE: Torsion bars are marked left (L) and right (R) and must not be interchanged.

2. On double joint axles, coat the inner rubber bushing with talcum and fit it over the torsion bar with the word "oben" at the top (**Figure 33**).

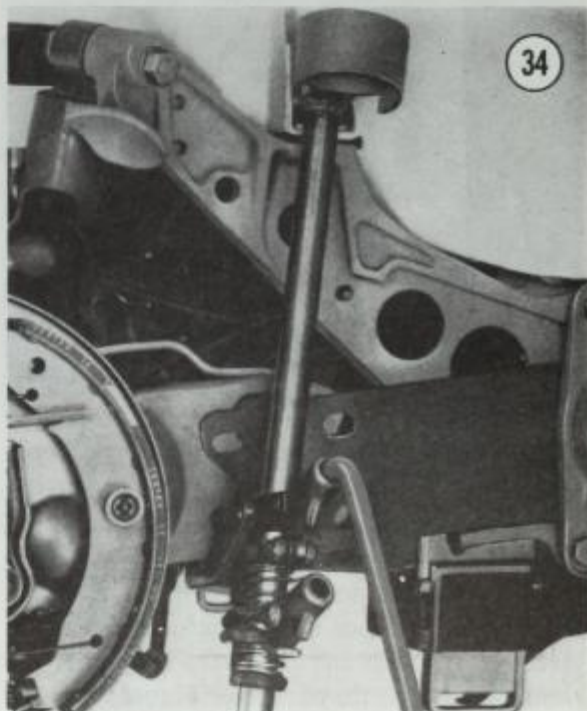


3. Install the spring plate and adjust it as described later.

4. Coat outer rubber bushing with talcum and install it with the word "oben" at the top.

5. Install the spring plate hub cover, but do not tighten the bolts.

6. Lift the spring plate as shown in **Figure 34** until its lower edge fits above the lower stop.



7. Tighten the spring plate hub cover bolts.

8. Clean mating surfaces between spring plate and axle bearing housing or trailing arm.

9. Bolt the spring plate to the bearing housing or trailing arm. Ensure that the chisel marks on the spring plate and bearing house or trailing arm line up. Tighten the bolts to 80 foot-pounds (11 mkg).

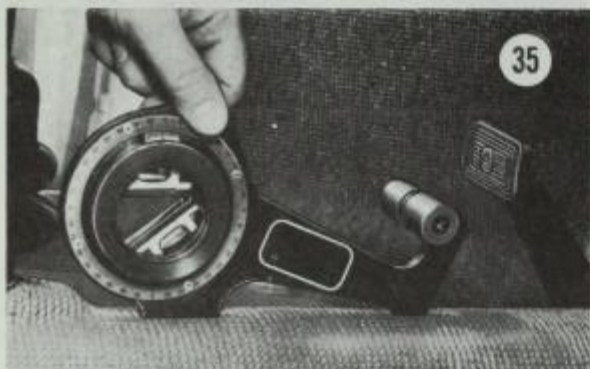
10. Connect and adjust handbrake cable. See Chapter Twelve.

Spring Plate Adjustment

In order to obtain proper wheel alignment and adequate spring travel under all load conditions, the spring plate angle must be adjusted on the torsion bar. There are 40 splines on the inner end of the torsion bar and 44 splines on the outer end. Turning the inner end of the bar 1 spline alters the spring plate angle 9°0'; turning the spring plate 1 spline on the bar alters the

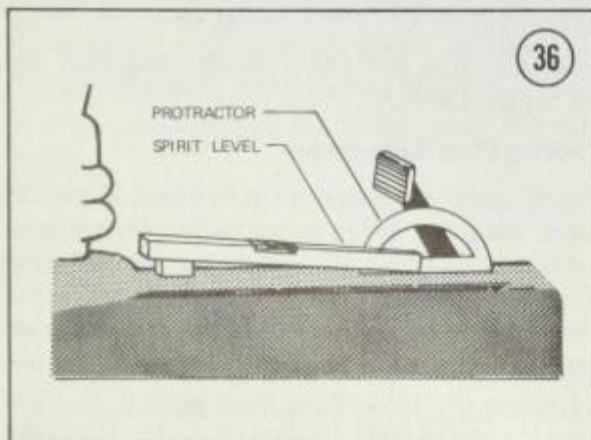
angle by $8^{\circ}10'$. Therefore, it is possible to set the spring plate angle at any multiple of $50'$ by turning the splines in opposite directions.

Measurement of this angle is most easily done with a special VW tool made for this purpose. See **Figure 35**. Since this tool is expensive and not easily available, the following procedure allows adjustment with simple tools. No doubt other tools on hand can be used.

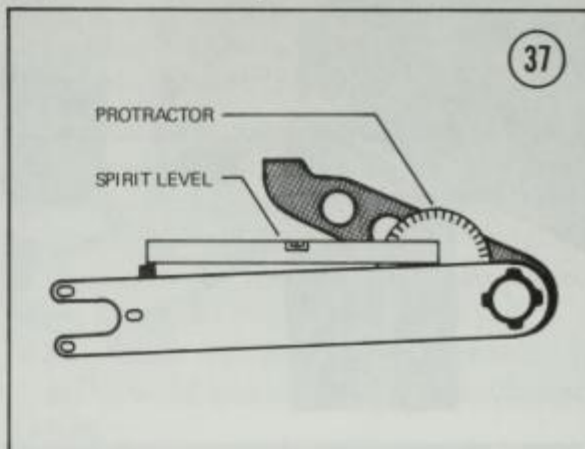


Always adjust both spring plates, even if only one was disassembled, especially if the car has high mileage.

1. Spring plate angle is measured in relation to the bottom of the door opening or frame tunnel. See **Figure 35**. Since it is doubtful if either surface is level with the car jacked up, first determine the angle the car slants. **Figure 36** shows one method. Place a protractor on the frame tunnel. Hold a spirit level against the protractor as shown in the figure; the bottom right corner of the level must touch the exact center of the protractor. Prop up the opposite end of the level until the spirit bubble is centered. Record the angle made by the level and the frame tunnel measured on the protractor.



2. Measure the spring plate angle as shown in **Figure 37**. Lift the plate lightly to remove any play. Record this angle.

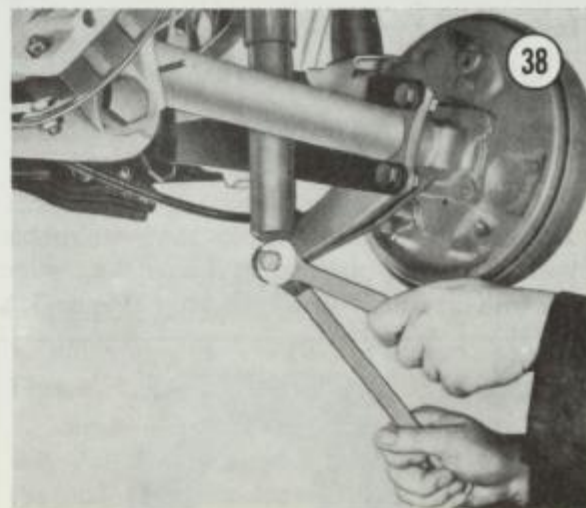


3. Subtract the angle measured in step 1 from the angle in step 2. The resulting angle should be the spring plate angle shown in the specifications for your model and year.

4. Move the torsion bar in its spline or move the spring plate on the torsion bar spline to correct the angle if necessary.

SHOCK ABSORBERS

1. Raise rear of car on jackstands.
2. Remove nuts securing top and bottom of shock absorber and then the shock absorber itself. See **Figure 38**.

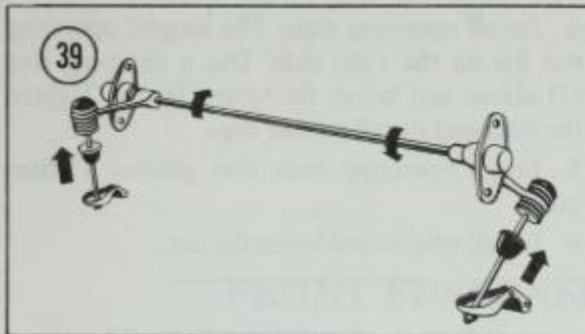


3. Installation is the reverse of these steps. If old shock absorbers are reinstalled, check the rubber bushings and replace them if necessary. Tighten nuts to 43 foot-pounds (6 mkg).

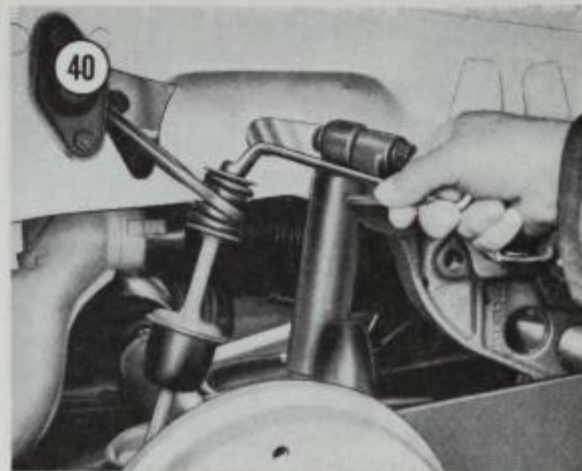
EQUALIZER SPRING (1967-1972)

Removal

1. Raise rear of car on jackstands and remove rear wheels.
2. Remove nuts on operating rods as shown in **Figure 39**.



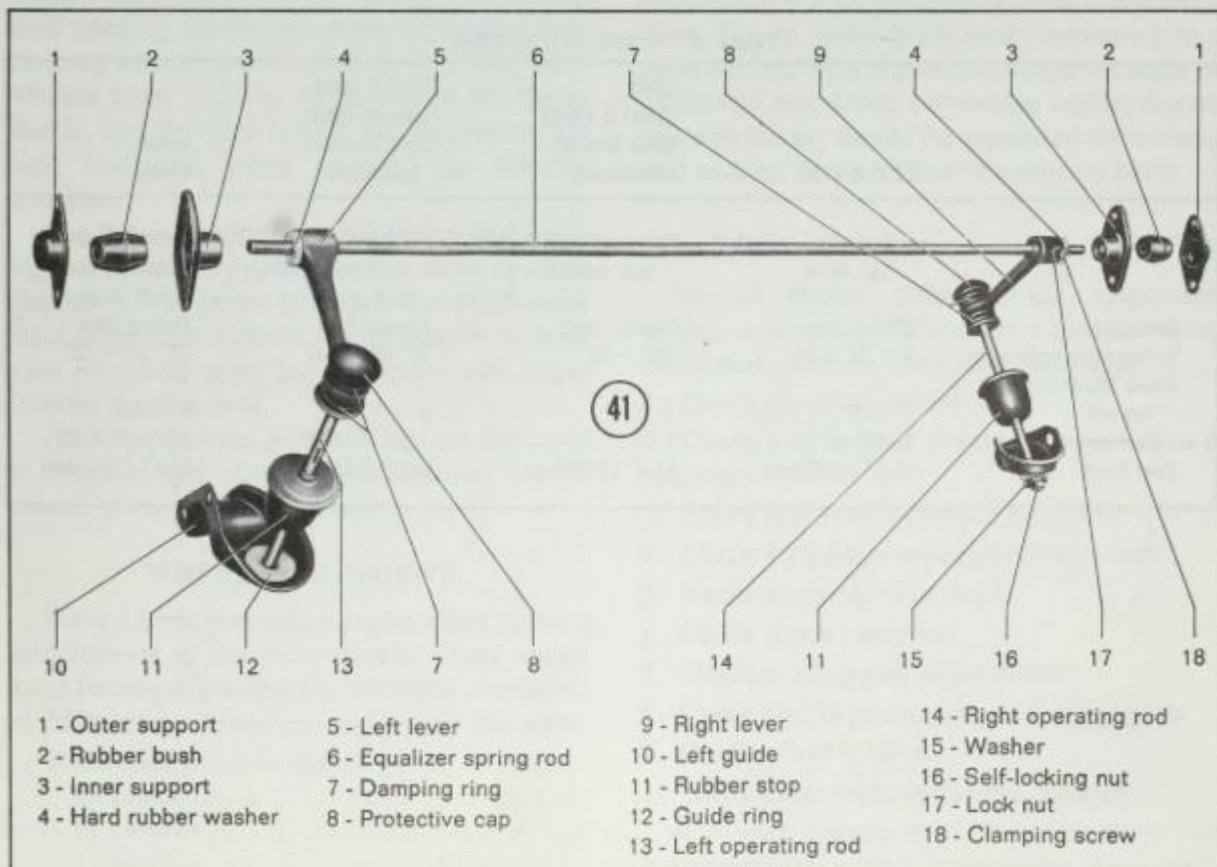
3. Remove rubber caps over top of operating rods and remove the nuts. See **Figure 40**.
4. Remove operating rods and rubber damper rings.
5. Remove nuts securing inner and outer supports (1 & 3, **Figure 41**). Remove supports and bushing.

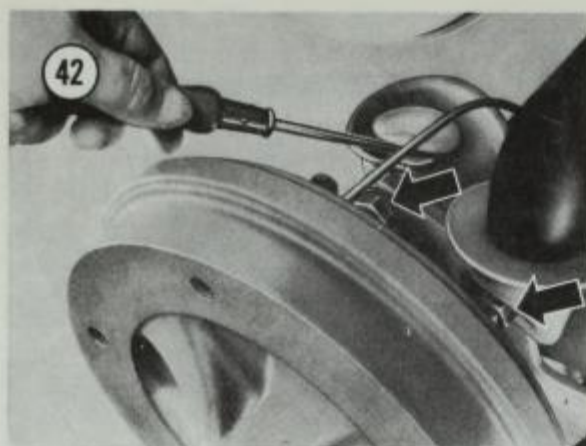


6. Loosen the lock nut and allen screw securing the left spring lever (5, **Figure 41**) and remove the lever.
7. Pull right spring lever and equalizer spring out together.

Inspection

1. Check operating rod guide rings and replace if necessary. They are easily pried out with a screw driver as shown in **Figure 42**.





2. Check the equalizer spring, bushings, and rubber stops for wear or deterioration.

Installation

Refer to Figure 41 for the following procedure.

1. Install the right spring lever on the equalizer spring. Tighten the allen screw and lock nut.
2. Install the spring in the car from the right, and install the left spring lever.

NOTE: The left spring lever is marked with an L; the right spring lever is unmarked. The right spring lever must point down and towards the FRONT when installed.

3. Install hard rubber washers (4) and supports (1 & 3) and rubber bushings (2).
4. Install operating rods. The longest operating rod fits on the right side. Use a damping ring (7) above and below the spring levers. Tighten the nuts and install rubber caps.
5. Insert operating rods into guides. Tighten nuts.
6. Install wheels and lower the car.

Table 1 TIGHTENING TORQUES

	foot-pounds	mkg
Axle tube retainer nuts	14	2.0
Bearing housing to spring plate	80	11.0
Drive shaft allen bolts	25	3.5
Wheel bearing cover bolts	40	5.5
Shock absorber nuts	43	6.0

Table 2 SPECIFICATIONS

	1200 & 1300	1500 (1967 & 1968) (with Manual Transaxle)	1500 & 1600 (except 1968) (with Manual Transaxle)	Super Beetle
Type	Independent swinging half axles	Independent swinging half axles	Independent double-jointed half axles	Independent double-jointed half axles
Springing	Torsion bars	Torsion bars	Torsion bars	Torsion bars
Spring plate inclination	17° 30' +50'	20° +50'	20° 30' +50'	20° 30' +50'
Wheel alignment				
Toe-out	5' ±10'	5' ±10'	0° ±15'	0° ±15'
Camber	2° 30' ±1°	1° ±1°	-1° 30' ±30'	-1° 20' ±40'
Rear track	51.2" (1300mm)	53.2" (1350mm)	53.2" (1350mm)	53.2" (1352mm)

CHAPTER ELEVEN

FRONT SUSPENSION AND STEERING

VW Beetle and Karmann Ghia front suspensions changed very little until the introduction of the Super Beetle. Front wheels on 1961-1965 models were independently sprung with torsion bars running across the front in large tubes. Steering knuckles are attached with king pins. Models from 1966 to 1972, except the Super Beetle, use the same torsion bar suspension except that ball joints connect the steering knuckles.

The Super Beetle front suspension and steering are completely different from those of other Beetles. VW's version of the popular McPherson strut suspension replaces the torsion bar suspension providing more luggage space and better interior arrangement.

All 3 suspensions, plus steering, are discussed in detail in this chapter. Specifications are included at the rear of the chapter.

WHEEL ALIGNMENT

Several front suspension angles affect running and steering of the front wheels. These angles must be properly aligned to maintain directional stability, ease of steering, and proper tire wear.

The angles involved define:

- a) caster
- b) camber
- c) toe-in

- d) steering axis or king pin inclination
- e) toe-out on turns

Only camber and toe-in are adjustable. Camber should not be adjusted without a front-end rack. Toe-in, however, is easily measured on a level surface with a good steel tape measure or calibrated rod. Other suspension angles, though not adjustable, should be measured on a front-end rack to check for bent suspension parts.

Pre-alignment Check

Several factors influence the suspension angles, or steering. Before any adjustments are attempted, perform the following checks.

1. Check tire pressure and wear.
2. Check play in front wheel bearings. Adjust if necessary.
3. Check play in ball-joints or king pins.
4. Check for broken springs or torsion bars.
5. Remove any excessive load.
6. Check shock absorbers.
7. Check steering gear adjustments.
8. Check play in pitman arm and tie rod parts.
9. Check wheel balance.
10. Check **rear** suspension for looseness.

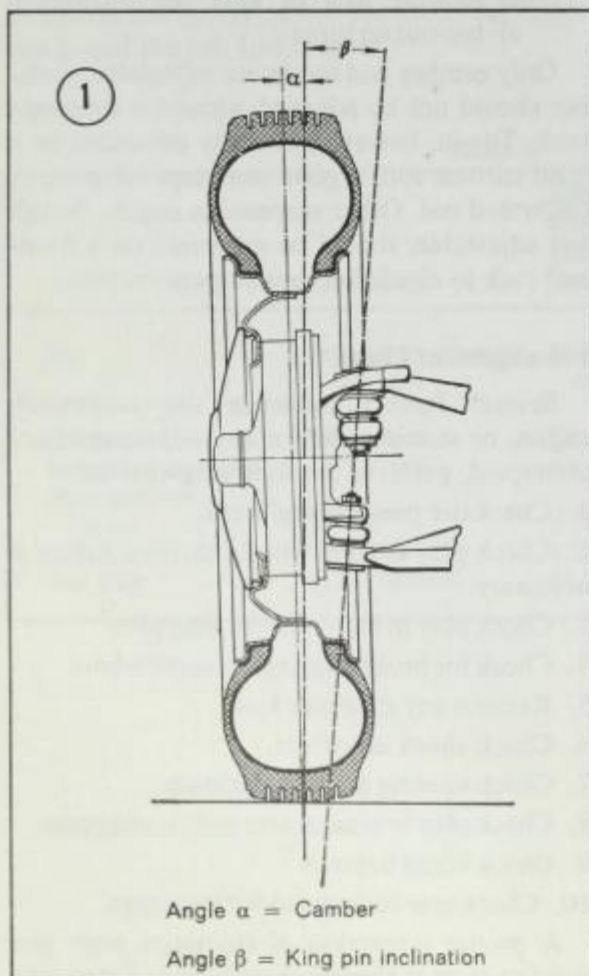
A proper inspection of front tire wear can point to several alignment problems. Tires worn

primarily on one side show problems with toe-in. If toe-in is incorrect on one wheel, the car probably pulls to one side or the other. If toe-in is incorrect on both wheels, the car is probably hard to steer in either direction. Incorrect camber may also cause wear on one side. Tire cupping (scalloped wear pattern) can result from worn shock absorbers, one wheel out of alignment, a bent spindle, or a combination of all. Tires which are worn in the middle, but not the edges, or worn nearly even on both edges, but not in the middle are probably over-inflated or under-inflated, respectively; these conditions are not caused by suspension misalignment.

Camber

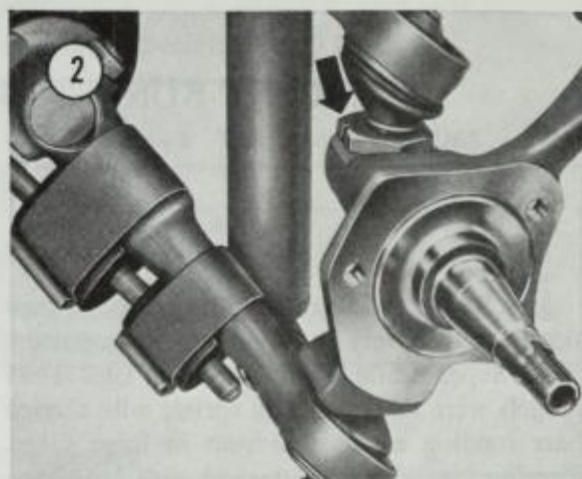
Camber is the inclination of the wheel from vertical, as shown in **Figure 1**. Note that angle (a) is positive camber, i.e., the top of the tire inclines outward more than the bottom.

Camber adjustment method varies with suspension type. King pin suspensions (1961-1965)



use shims to adjust camber. This is not an adjustment in the usual sense. As long as the steering knuckle is installed properly, adjustment is automatic. If camber changes for any reason, check for bent suspension parts.

Ball joint suspensions have a true camber adjustment. Upper ball joints are located in adjustable eccentric bushings. After loosening the ball joint mounting nut, the camber adjuster can be turned. Note that the notch in the nut (**Figure 2**) must always face forward. This restricts movement of the adjustment to 45° either side of dead ahead.



Super Beetle suspensions also are easily adjusted. Both track control arms are mounted to the floor pan with eccentric bolts. Rotating the bolts varies wheel camber.

Caster

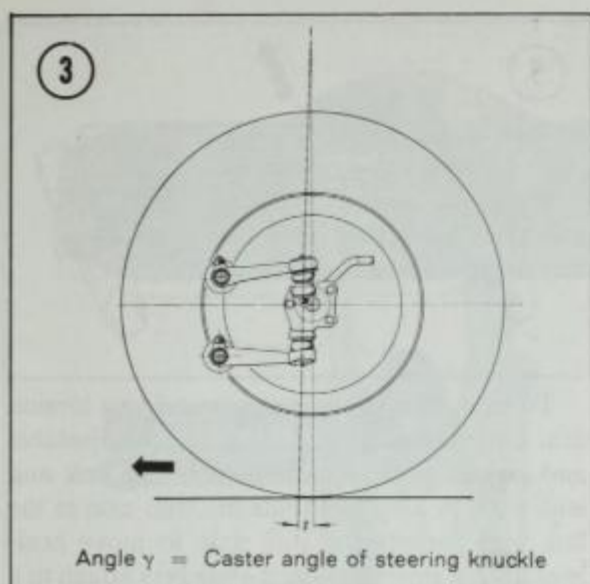
Caster is the inclination of the axis through the ball joints or king pins from vertical. See **Figure 3**. The VW has negative caster, i.e., the wheel is shifted rearward. Caster causes the wheels to return to a position straight ahead after a turn. It also prevents the car from wandering due to wind, potholes or uneven road surfaces.

Caster is a function of torsion arm design and cannot be adjusted on a VW.

King Pin or Steering Axis Inclination

Steering axis inclination for a ball joint suspension is shown in **Figure 1**. On Super Beetles, steering axis inclination is the inclination of the strut from vertical.

This angle is called king pin inclination when

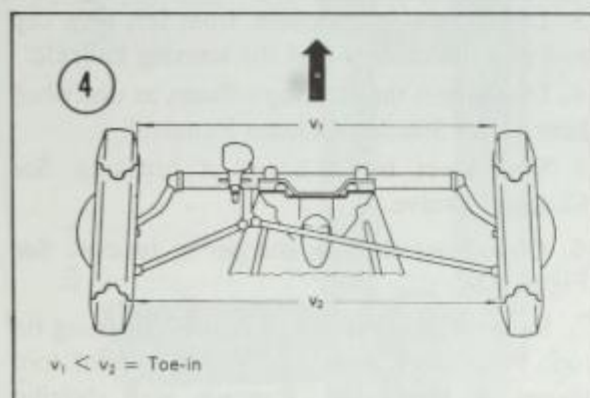


referring to king pin suspensions. It defines the inclination of the king pin from vertical.

King pin and steering axis inclination are design functions and are not adjustable.

Toe-in

Camber and rolling resistance tend to force the front wheels outward at their forward edge. To compensate for this tendency, the front edges are turned slightly inward when the car is at rest—this is toe-in. See Figure 4. Unlike other suspension angles, toe-in is easily adjusted.

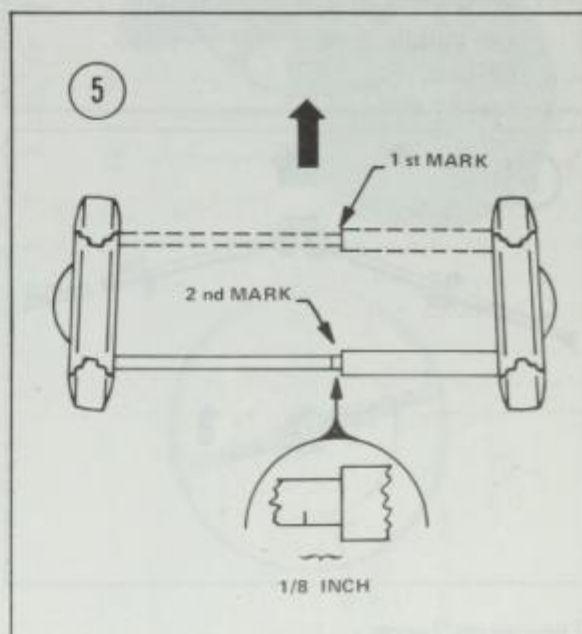


To check toe-in:

1. Drive the car onto any level smooth surface such as a driveway or parking lot. The front wheels must point straight ahead. One method of ensuring this is to take advantage of wheel caster. Drive the car straight forward without touching the steering wheel. Stop the car with the hand brake. The wheels should stop straight ahead.

2. Mark the inside wheel rim at 3 o'clock and 9 o'clock using chalk.

3. Measure the distance between forward chalk marks. Two pieces of telescoping aluminum tubing spanning the distance makes an accurate tool. Place this tool between the forward edges of the wheels rims, and telescope the tubing so each end contacts the chalk marks. Mark the small diameter tubing exactly where it enters the large tube with a sharp scribe. See Figure 5.

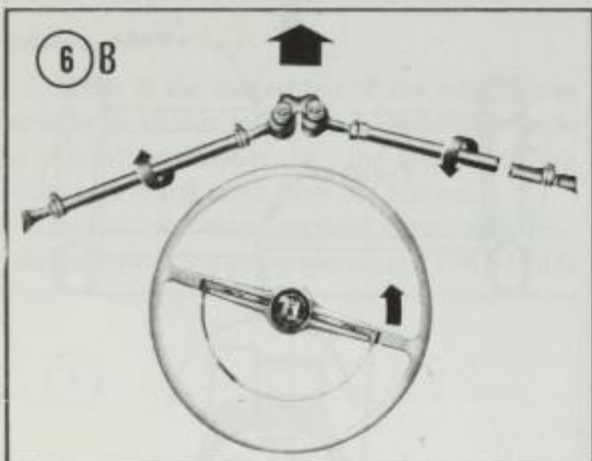
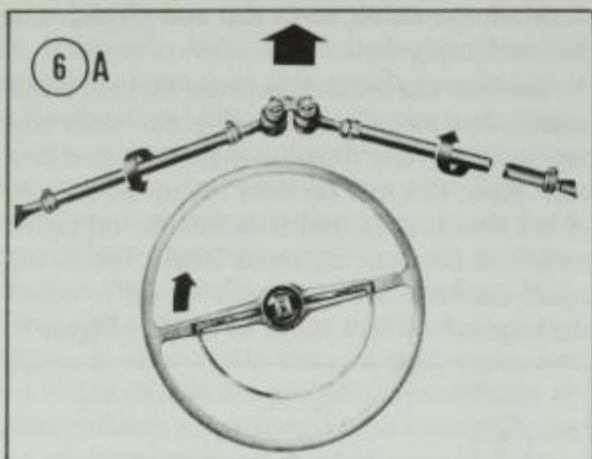


4. Measure between the rear chalk marks with the telescoping tubes. Make another mark on the small tube where it enters the large tube. There should be 2 scribe marks exactly $\frac{1}{8}$ " (3.2mm) apart, i.e., the front measurement is $\frac{1}{8}$ " less than the rear measurement. If toe-in is not correct, adjust as described below.

To adjust toe-in:

1. Turn the front wheels straight ahead as described in step 1 of the checking procedure.
2. If the steering wheel spokes are **not** horizontal when the wheels are straight ahead, this must be corrected before adjusting toe-in. If the steering wheel is turned to the left, adjust tie rods in the direction shown in Figure 6A. If the steering wheel is turned to the right, adjust tie rods as shown in Figure 6B.

NOTE: Never correct steering wheel position by repositioning the steering wheel on the column.

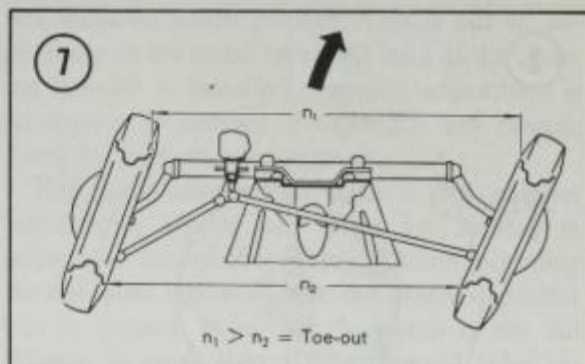


Toe-out on Turns

Since the front wheels are at different radii from a common center of turn, the wheels must be turned at different angles. The inside wheel in a turn is always at a greater angle than the outside wheel. In **Figure 7**, which shows a right turn, N_1 is greater than N_2 ; therefore there is slight toe-out as a result of the turn. Toe-out is not adjustable on VW Beetles.

KING PIN SUSPENSION

The king pin suspension consists of upper and lower laminated torsion bars running parallel across the car, supporting 2 trailing arms per wheel. See **Figures 8A and 8B**. Large axle tubes contain torsion bars and bolt to the floor pan. Torsion bars are rigidly secured at the center forming, in effect, 4 separate torsion bars. Torsion arms (trailing arms) fit over the ends of the torsion bars, and extend partially inside the axle tube. The inner end is supported by a replaceable bushing; the outer end by a needle bearing.



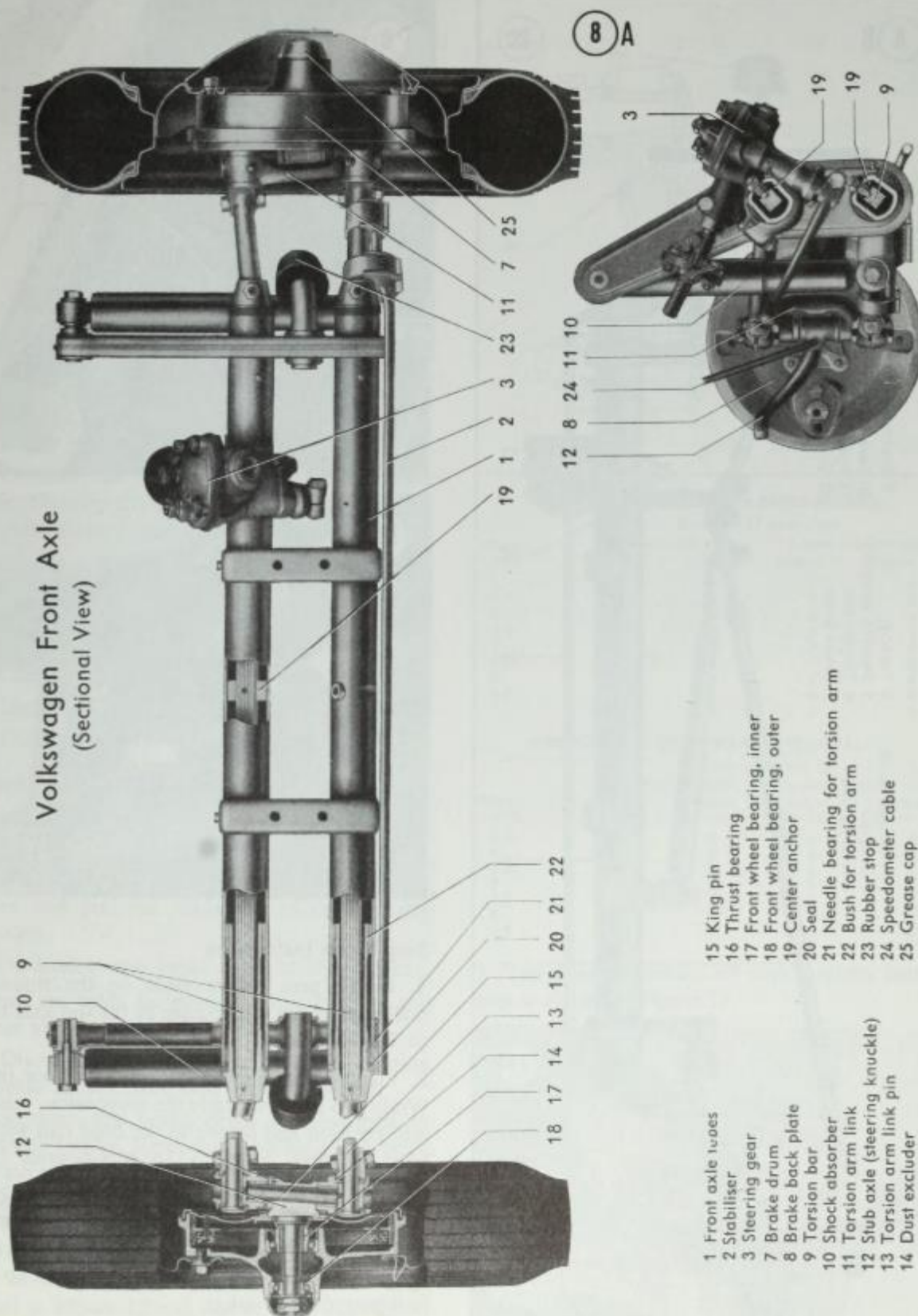
Torsion arms connect at one end to a torsion arm link via link pins. Link pins are adjustable and permit vertical movement of the link and stub axle. A king pin holds the stub axle in the link and permits the stub axle to move horizontally for steering. Shock absorbers attach to a bracket on the upper axle tube and the lower torsion arm to dampen vertical movement.

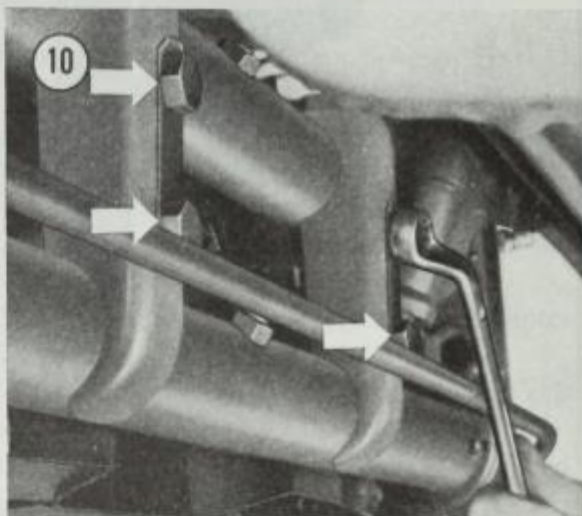
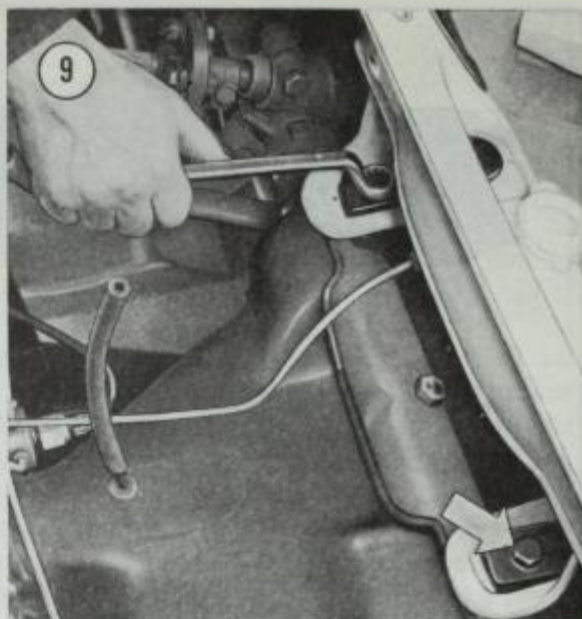
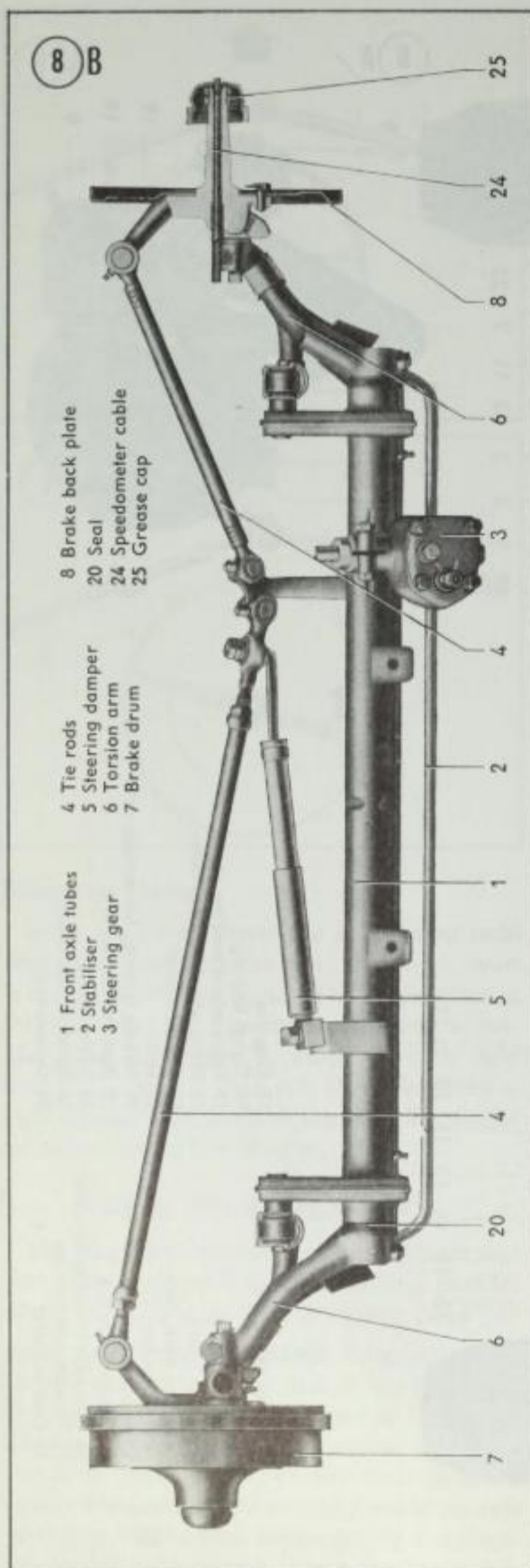
Suspension Removal

The entire front suspension can be removed as a unit to facilitate certain repairs. In addition, front suspensions damaged beyond repair, e.g., in an accident, can be replaced completely.

1. Raise the car on jackstands and remove the front wheels.
2. Remove fuel tank as described in Chapter Six.
3. Disconnect speedometer from left dust cap and pull the cable out of the steering knuckle.
4. Disconnect the steering column as described later under Steering Column Removal.
5. Disconnect brake hoses at brackets. See Chapter Twelve.
6. Disconnect steering damper at bracket. See **Figure 47**.
7. Remove the tie rod end nuts on the long tie rod. Press both ends out with a special tool shown in **Figure 49**. Remove with steering damper still attached.
8. Remove 2 bolts at upper edge of top axle tube. See **Figure 9**.
9. Loosen 4 screws securing front axle to front floor pan. See **Figure 10**.
10. Place a garage-type floor jack under the front suspension assembly. Have two helpers steady the suspension on the floor jack. Remove 4 bolts holding the suspension and lower it.

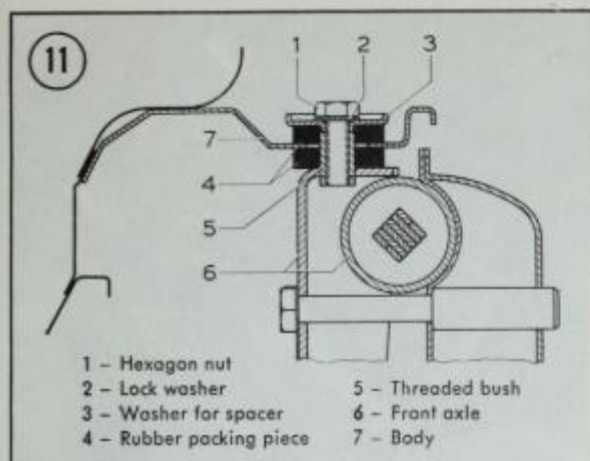
Volkswagen Front Axle
(Sectional View)





Suspension Installation

1. Install new rubber pads on the threaded bushings on the upper edge of the top axle tube (4, Figure 11).
2. Place suspension on garage-type floor jack. While two helpers steady the suspension, raise it into position and secure to the floor pan with 4 bolts. Tighten bolts to 36 foot-pounds (5.0 mkg).
3. Install new rubber pads on body over threaded bushings (4, Figure 11). Install spacers (3), lockwashers (2), and bolts (1). Tighten to 14 foot-pounds (2.0 mkg).
4. Install the long tie rod with steering damper. Tighten tie rod nuts to 22 foot-pounds (3.0 mkg).



and the steering damper bolts to 18 foot-pounds (2.5 mkg). Turn tie rod nut additionally if necessary to install the cotter pin.

5. Connect the steering column as described under Steering Column Installation later in this chapter. Ensure that the wheels point straight ahead and the steering wheel spokes are horizontal.

6. Connect brake hoses. Bleed and adjust the brakes. See Chapter Twelve.

7. Connect speedometer cable.

8. Install fuel tank. See Chapter Six.

9. Check and adjust toe-in.

Steering Knuckle Removal

1. Raise front of car on jackstands and remove the wheel.

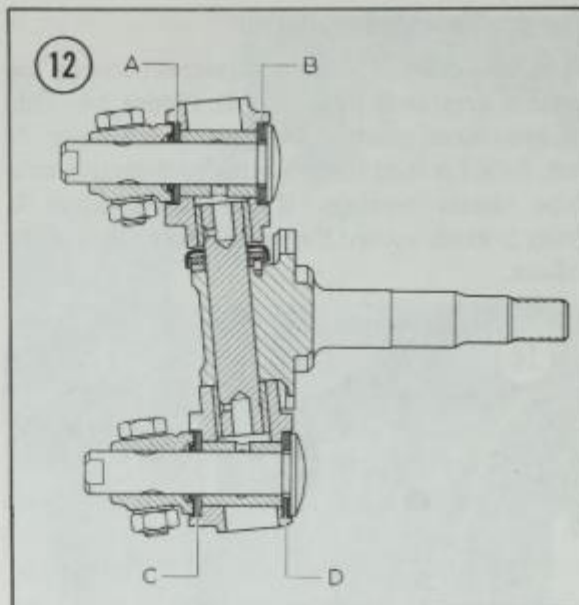
2. Disconnect speedometer cable from left dust cover and pull the cable out of the steering knuckle.

3. Disconnect the brake hose at the bracket. Cover the ends to prevent entry of dirt and water vapor.

4. Disconnect the tie rod end from the steering knuckle as described later in this chapter.

5. Remove the brake drum as described in Chapter Twelve. Remove the backing plate from the steering knuckle. It is unnecessary to remove brake shoes from backing plate.

6. Remove the clamp bolts securing the steering knuckle to the torsion arms. Count the number of wheel camber shims at the points indicated in **Figure 12** and record each number on the figure for future reference. There should be 8 shims total on each link pin.



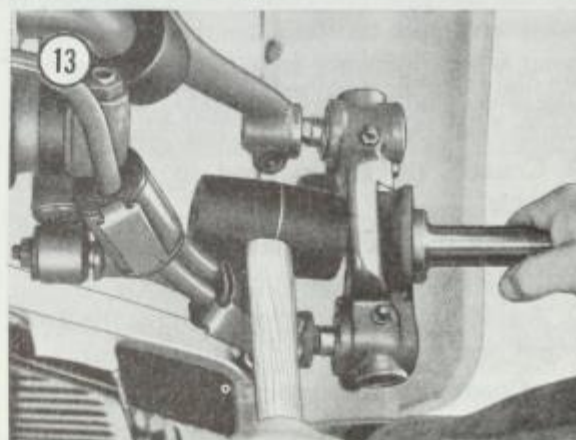
ARRANGEMENT OF SHIMS IN EARLY MODELS

Offset in mm	Number of shims on			
	Upper control arm		Lower control arm	
	Shims A	Shims B	Shims C	Shims D
5	3	7	7	3
5.5	4	6	7	3
6	4	6	6	4
6.5	5	5	6	4
7	5	5	5	5
7.5	6	4	5	5
8	6	4	4	6
8.5	7	3	4	6
9	7	3	3	7

ARRANGEMENT OF SHIMS IN LATE MODELS

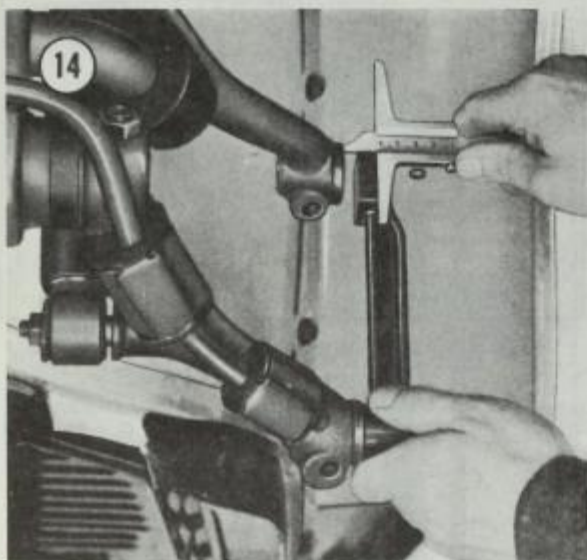
Offset in mm	Number of Shims for			
	Upper Torsion Arm		Lower Torsion Arm	
	Inner Shims A	Outer Shims B	Inner Shims C	Outer Shims D
5.5	2	6	5	3
6	2	6	4	4
6.5	3	5	4	4
7	3	5	3	5
7.5	4	4	3	5
8	4	4	2	6
8.5	5	3	2	6

7. Tap steering knuckle off with a rubber hammer as shown in **Figure 13**.

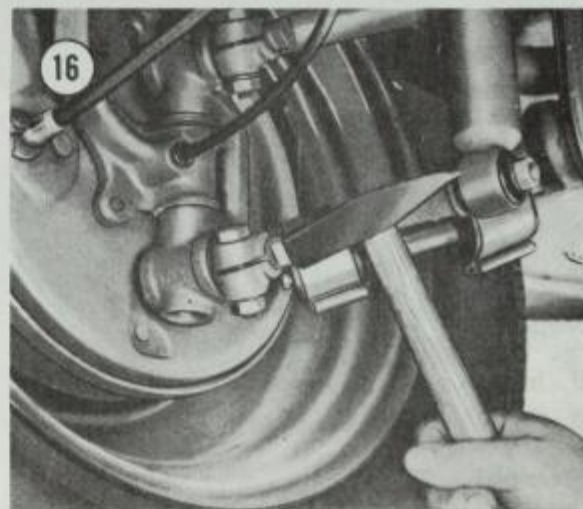
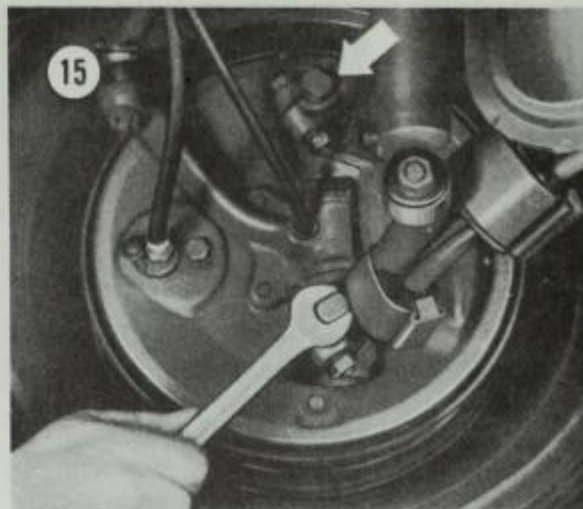


Steering Knuckle Installation

1. Measure the offset in millimeters between the torsion arm ends as shown in **Figure 14**. This measurement must be between 5 and 9mm. If not, look for bent torsion arms or defective axle tube needle bearings. If the measurement is from 5-9mm, record the exact figure. This is the off-set.



2. Refer to Figure 12. Compare the number of shims required for the off-set measured in step 1 to the number removed. If the numbers don't agree, use the numbers in the figure.
3. Install the shims and link pins on the steering knuckle.
4. Install the steering knuckle on the torsion arms.
5. Insert the link pin clamp bolts. Turn the link pins until the bolts go through.
6. To adjust and tighten the link pins, first tighten the link pin, then loosen it about $\frac{1}{8}$ turn. See **Figure 15**. Retighten the pin just to the point when resistance is felt. Tap the ends of the pins lightly (see **Figure 16**). Tighten the clamp bolt. Do this for all 4 link pins.
7. Connect the tie rod end to the steering knuckle.
8. Install the backing plate with brake shoes. Connect the brake hose.
9. Install the brake drum. Adjust the front wheel bearings. Bleed and adjust the brakes.
10. Connect the speedometer.
11. Install the wheels and lower the car.

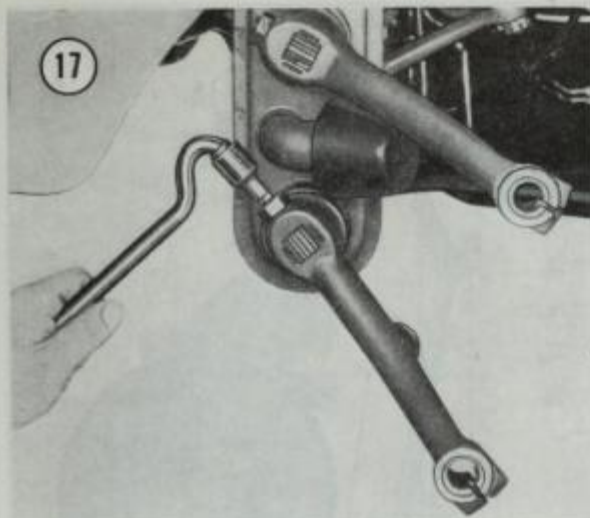


King Pin & Bushing Replacement

King pin and bushing replacement requires several special tools including a hydraulic press. Remove the steering knuckle as described previously. Take the steering knuckle, king pin repair kit, and link pin repair kit to a VW dealer or front end shop.

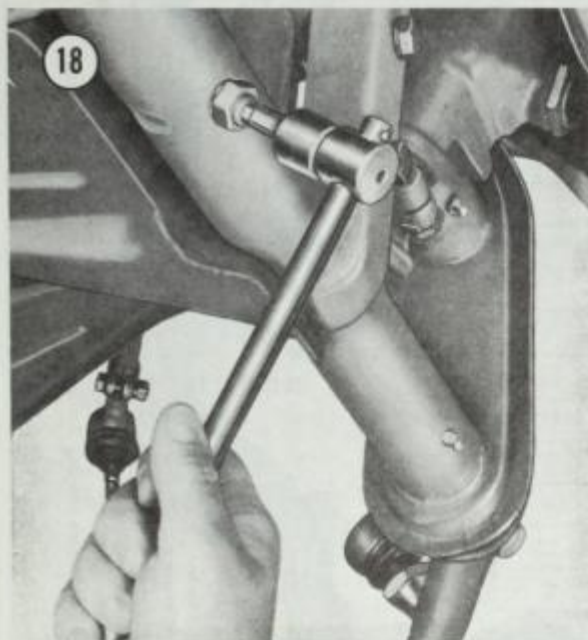
Torsion Arm Removal/Installation

1. Remove steering knuckle complete with backing plate and brake drum as described earlier.
2. Remove stabilizer and shock absorber if lower torsion arm is to be removed.
3. Loosen the lock nuts on torsion arm pins and screw the pins out. See **Figure 17**.
4. Pull torsion arm off.
5. Installation is the reverse of these steps. Check wheel alignment.



Torsion Bar Removal

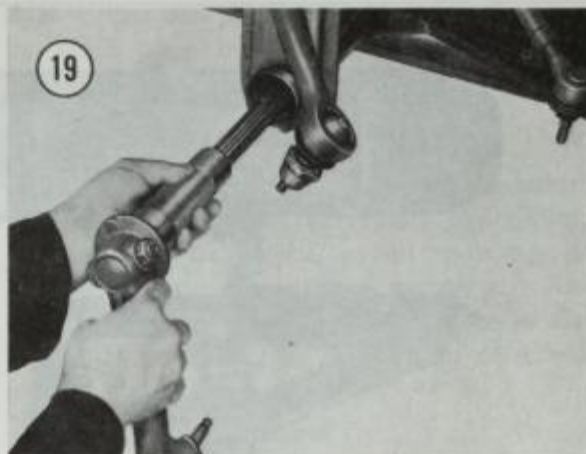
1. Remove steering knuckles complete with backing plates and brake drums as described earlier.
2. Remove torsion arm on one side of torsion bar. See previous procedure.
3. Loosen torsion bar retaining bolt lock nut. Remove retaining bolt. See **Figure 18**.



4. Pull torsion arm out with torsion bar attached. See **Figure 19**.

Torsion Bar Inspection

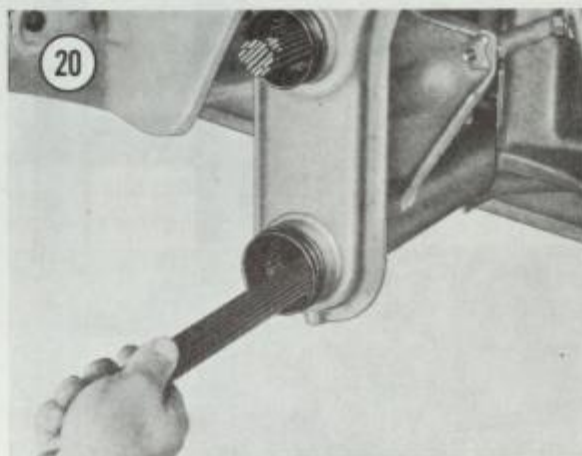
1. Clean torsion bars with solvent. Check for cracks or breaks. Install new bars if necessary.



2. Check torsion arms, needle bearings, and bushings in axle tubes. Bearing and bushing replacement must be done by a VW dealer. Remove entire front suspension and take it to the dealer.

Torsion Bar Installation

1. Liberally coat bars with universal grease.
2. Insert the torsion bar in the axle tube. Position the countersunk recess in the bar so it points forward at about a 45° angle. See **Figure 20**.

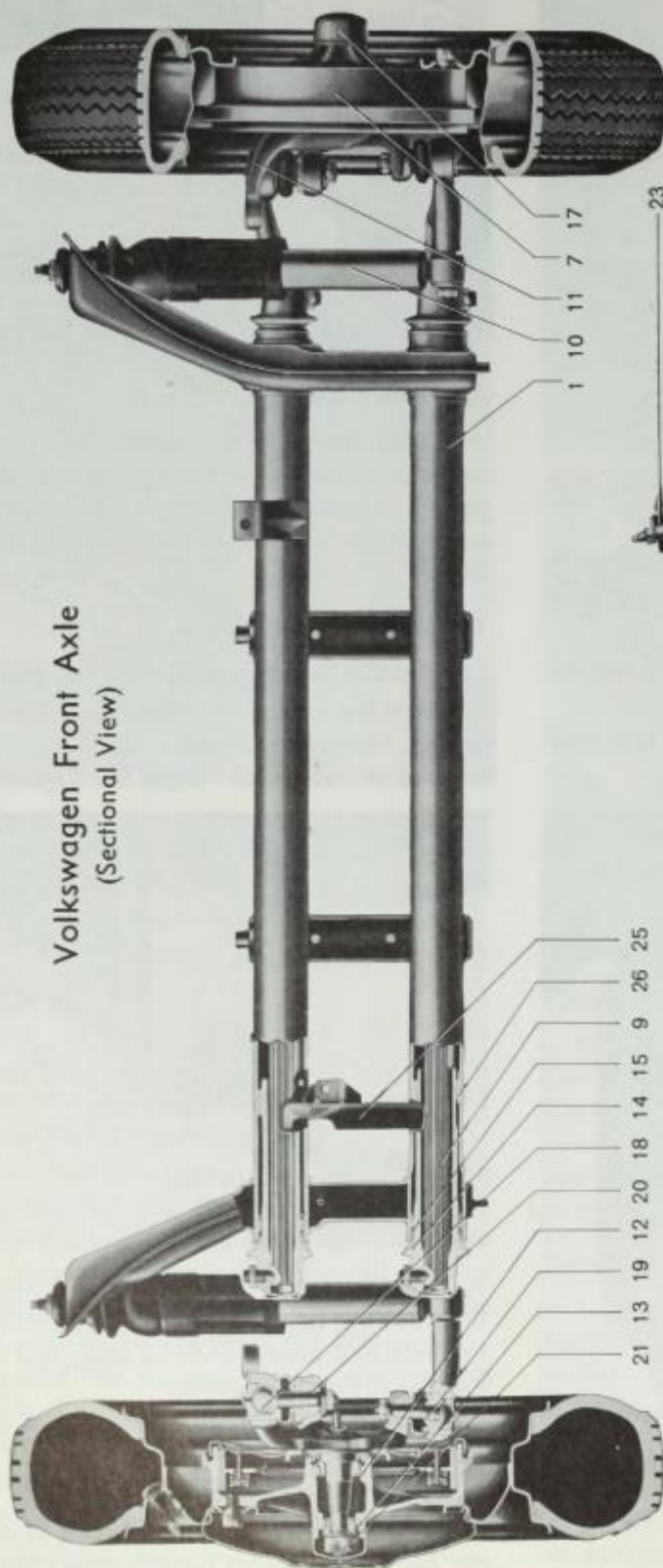


3. Align the recess in the center of the bar with the retaining bolt hole. Install the bolt, tighten to 29-36 foot-pounds (4.0-4.5 mkg), and tighten lock nut to the same torque.
4. Install the torsion arms as described earlier.

BALL JOINT SUSPENSION

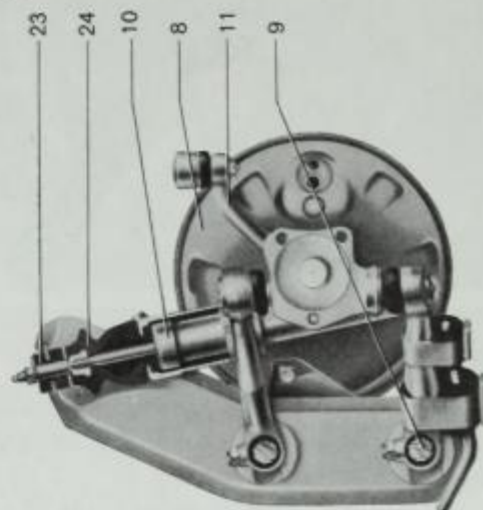
The ball joint suspension is similar to the king pin suspension except torsion arms connect to the steering knuckle via ball joints instead of link pins and king pins. See **Figures 21A and**

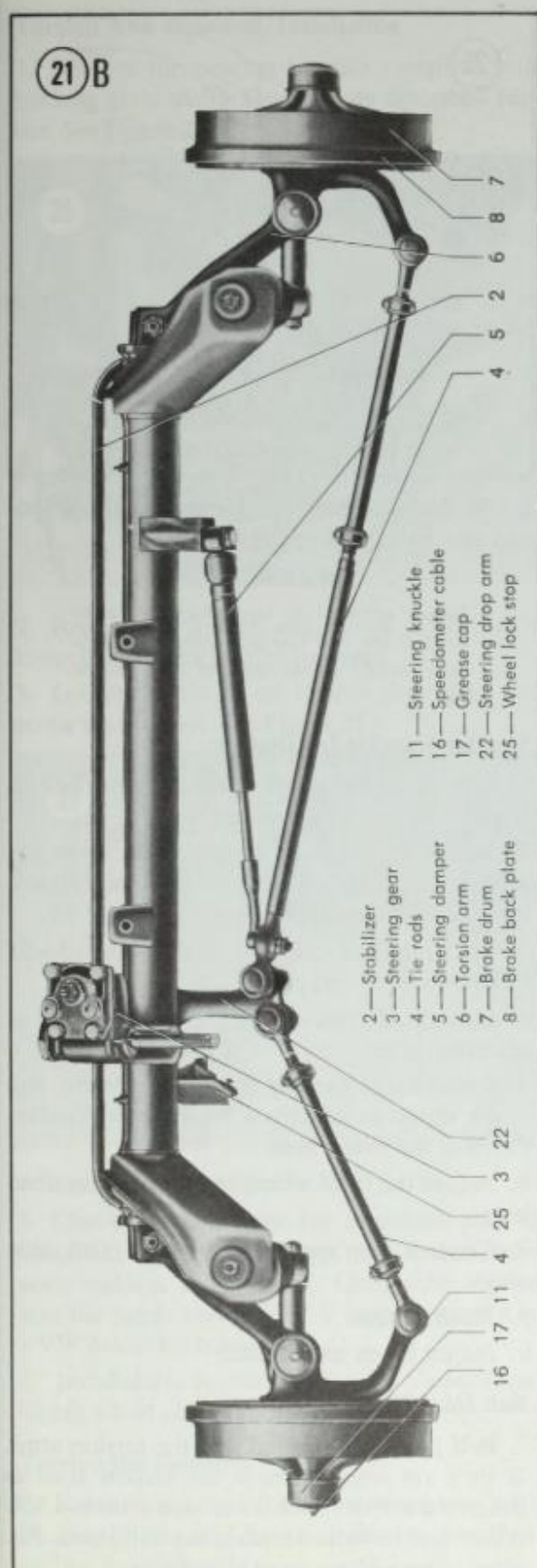
Volkswagen Front Axle
(Sectional View)



- 1 - Front axle beam
- 7 - Brake drum
- 8 - Brake back plate
- 9 - Torsion bar
- 10 - Shock absorber
- 11 - Steering knuckle
- 12 - Inner wheel bearing
- 13 - Outer wheel bearing
- 14 - Torsion arm seal
- 15 - Torsion arm needle bearing

- 16 - Speedometer cable
- 17 - Grease cap
- 18 - Upper ball joint
- 19 - Lower ball joint
- 20 - Eccentric bush for chamber adjustment
- 21 - Clamp nut for wheel bearing adjustment
- 23 - Damper ring
- 24 - Rubber stop
- 25 - Wheel lock stop
- 26 - Plastic seating and metal bushing





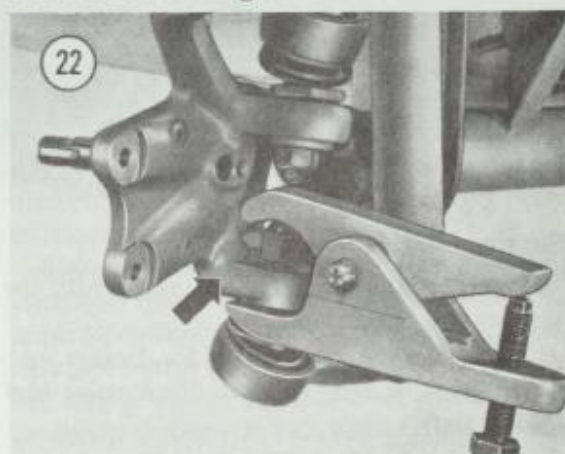
21B. Upper ball joints fit in eccentric bushings by which wheel camber can be adjusted. See Chapter Two for lubrication and maintenance.

Suspension Removal/Installation

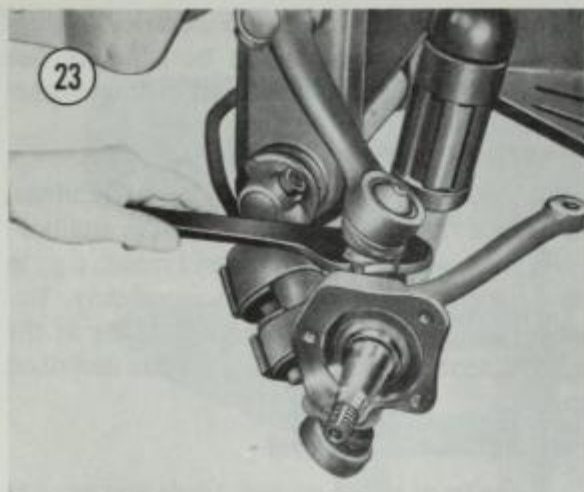
The entire front suspension can be removed as a unit to facilitate certain repairs. In addition, front suspension damaged beyond repair, e.g., in an accident, can be replaced completely. Remove and install ball joint suspensions in the same manner as king pin suspensions described earlier.

Steering Knuckle Removal

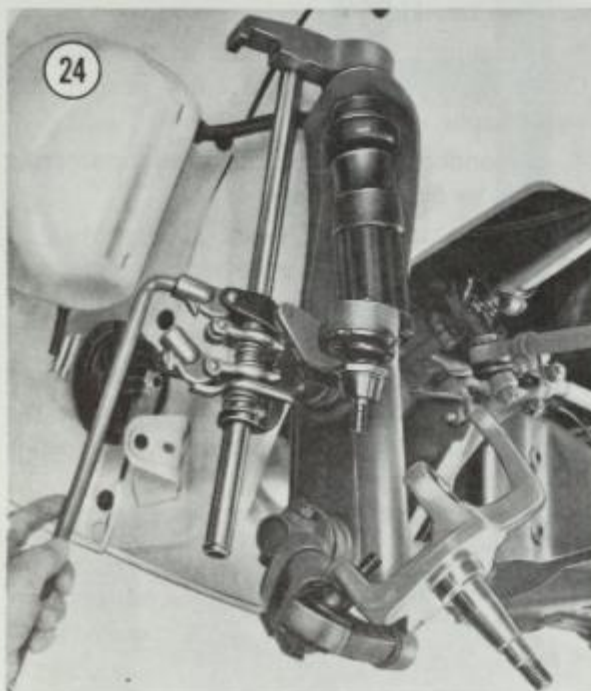
1. Raise front of car on jackstands and remove the wheel.
2. Disconnect the speedometer cable from the left dust cover and pull the cable out of the steering knuckle.
3. Disconnect the brake hose at the bracket. Cover the ends to prevent entry of dirt and water vapor.
4. Disconnect the tie rod end from the steering knuckle as described later.
5. Remove the brake drum as described in Chapter Twelve. Remove the backing plate from the steering knuckle. It is unnecessary to remove brake shoes from backing plate.
6. Remove the lower ball joint nut. Screw an acorn nut onto the ball joint to protect the threads and press the ball joint out with a special tool as shown in **Figure 22**.



7. Remove the upper ball joint nut and loosen the camber adjustment. See **Figure 23**. Press out the upper ball joint in the same manner as the lower ball joint.



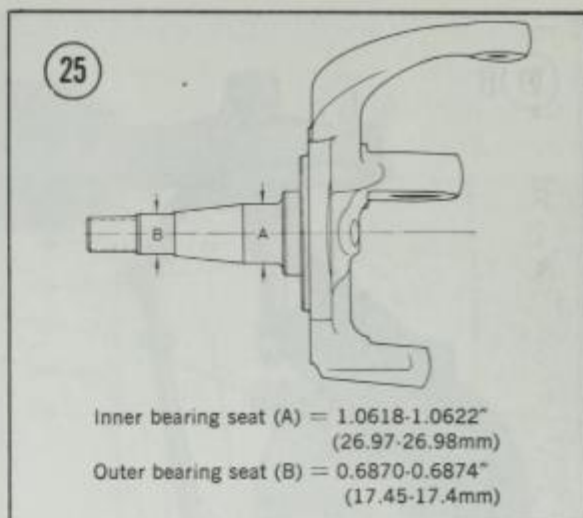
8. Lift the upper torsion arm far enough to remove steering knuckle. **Figure 24** shows the special tool used by VW to lift the torsion arm.



Steering Knuckle Inspection

This procedure can be performed with the steering knuckle installed.

1. Check the bearing surfaces for damage such as scratches, scoring or signs of excessive heat (bluish tint).
2. Measure bearing surfaces and compare to **Figure 25**.
3. Visually examine the steering knuckle for bends, cracks, or other damage. A steering knuckle suspected of bends should be taken to



a VW dealer for testing. A large variety of special test fixtures is required.

WARNING

Never attempt to straighten or reuse bent front end components. They are structurally weakened and may fail in use.

Steering Knuckle Installation

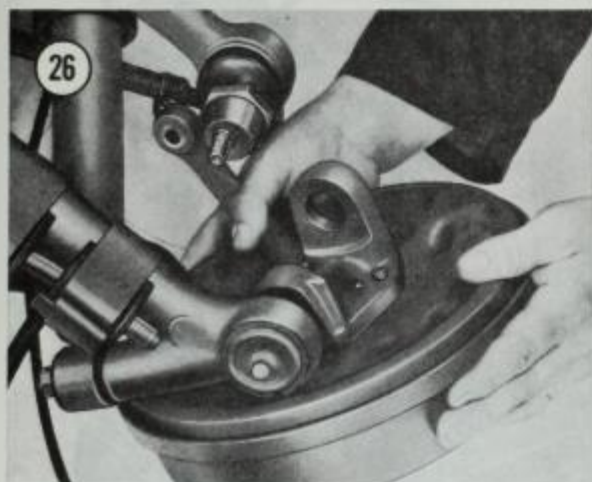
1. Lift the upper torsion arm as described in step 8 of the removal procedure.
2. Install the steering knuckle and lower the torsion arm. Ensure that the camber adjustment notch points forward as shown in **Figure 23**.
3. Install the ball joint nuts and tighten to 36-51 foot-pounds (5-7 mkg).
4. Connect tie rod end to steering knuckle as described later.
5. Install brake backing plate, brake drums, and brake shoes as described in Chapter Twelve. Connect the brake hose.
6. Adjust the front wheel bearings as described later.
7. Connect the speedometer cable (left side only).
8. Bleed brakes.
9. Adjust toe-in and camber.

Ball Joint Replacement

Ball joints are pressed into the torsion arms. If they are worn, remove the torsion arms as described earlier. Take the torsion arms to a VW dealer and have him replace the ball joints. Replace joints which exceed wear limits.

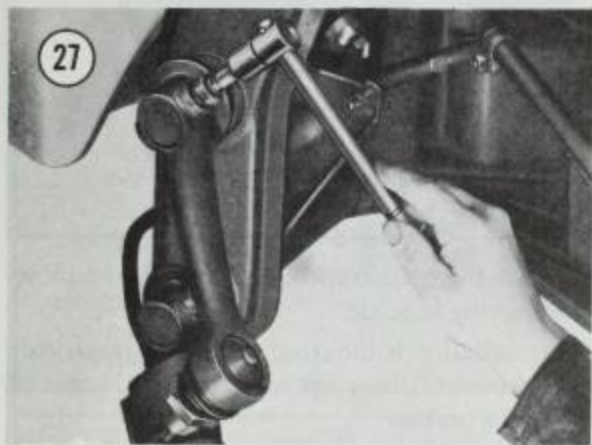
Torsion Arm Removal/Installation

1. Remove the steering knuckle complete with backing plate and brake drum as described earlier. See **Figure 26**.



2. Remove stabilizer and shock absorber if lower torsion arm is to be removed.

3. Loosen lock nuts on torsion arm pins, and screw the pins out. See **Figure 27**.



4. Pull torsion arm off.

5. Check the ball joint for excessive play as described in Chapter Three. Check the axle tube seal; replace, if necessary. Check the torsion arm for bends and cracks. If suspect, take it to a VW dealer for testing.

6. Installation is the reverse of these steps. Check wheel alignment.

Torsion Bar Removal

1. Remove steering knuckles complete with backing plates and brake drums as described earlier. See **Figure 26**.

2. Remove torsion arm on one side of torsion bar. See previous procedure.

3. Loosen torsion bar retaining bolt lock nut. Remove retaining bolt. See **Figure 18**.

4. Pull torsion arm out with torsion bar attached. See **Figure 19**.

Torsion Bar Inspection

1. Clean torsion bars with solvent. Check for cracks or breaks. Install new bars if necessary.

2. Check torsion arms, needle bearings, and bushings in axle tubes. Bearing and bushing replacement must be done by a VW dealer. Remove entire front suspension and take it to the dealer.

Torsion Bar Installation

1. Liberally coat bars with universal grease.

2. Insert the torsion bar in the axle tube. Position the countersunk recess in the bar so it points forward at about a 45° angle. See **Figure 20**.

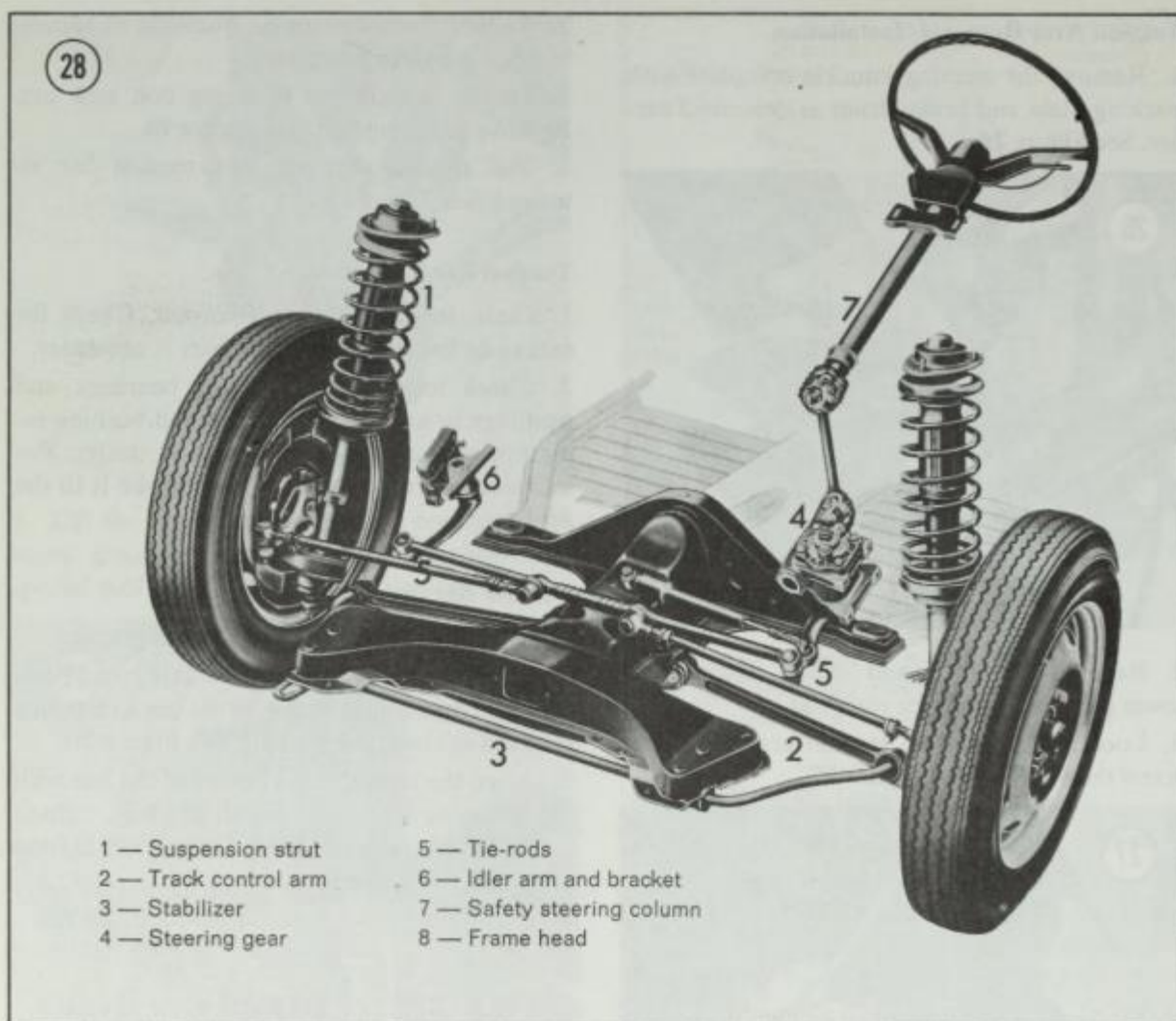
3. Align the recess in the center of the bar with the retaining bolt hole. Install the bolt, tighten to 29-36 foot-pounds (4.0-4.5 mkg), and tighten lock nut to the same torque.

4. Install the torsion arms as described earlier.

SUPER BEETLE STRUT SUSPENSION

The Super Beetle front suspension represents a significant deviation from the traditional torsion bar suspension used on other Beetles. This suspension, a version of the McPherson strut suspension, is used successfully on several other cars including the VW 411. This suspension requires a slightly longer front end, but it permits a much larger luggage compartment and better interior arrangement.

The complete front suspension including steering is shown in **Figure 28**. The front wheels are independently suspended on struts each consisting of a large shock absorber and progressive coil spring. The top of each strut is attached to the body through a ball bearing and rubber mount. The bottom of each strut bolts to a steering knuckle and ball joint and is held in position by a track control arm. Track control arms attach to the frame with eccentric bolts to permit front wheel camber adjustment.



Steering Knuckle Removal/Installation

1. Raise front of car on jackstands and remove front wheels.
2. Remove stabilizer as described later.
3. Disconnect tie rod from steering knuckle as described later.
4. Disconnect brake line from bracket on shock absorber. Plug the line to prevent entry of dirt and water vapor.
5. Disconnect speedometer cable from steering knuckle (left side only) and pull it free. See Chapter Seven.
6. Remove the brake drum and brake shoes as described in Chapter Twelve. Remove the backing plate from the steering knuckle.
7. Remove 3 bolts connecting the shock absorber, steering knuckle, and ball joint. See Figure 29.

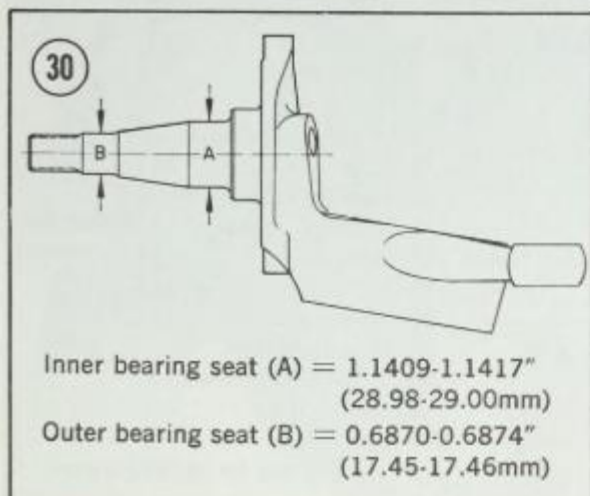
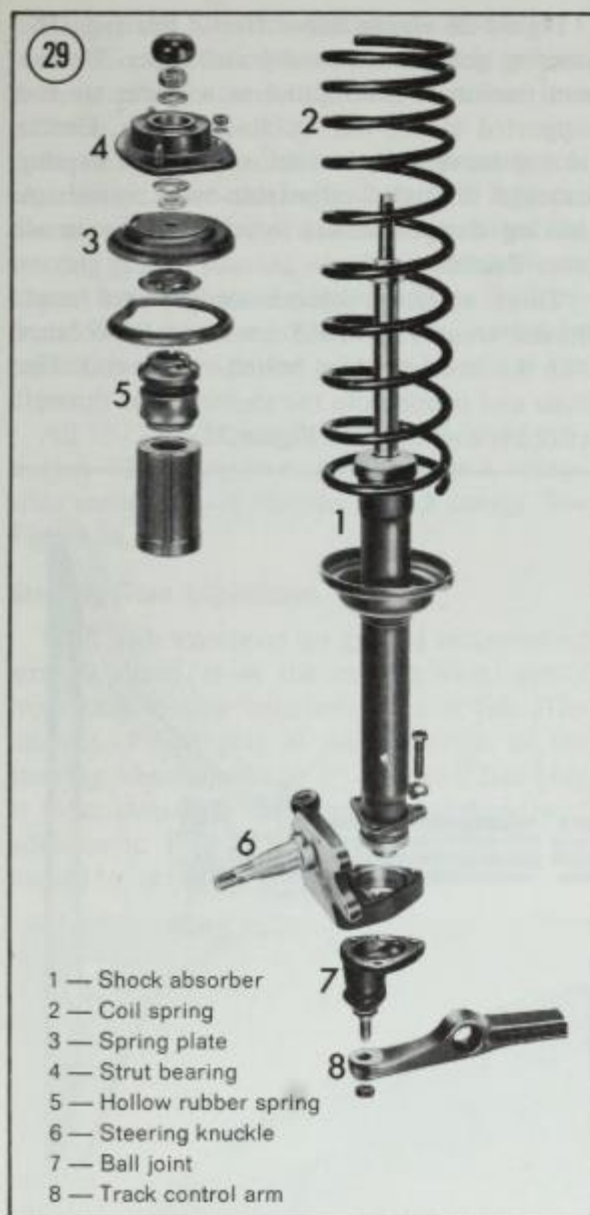
8. Push the track control arm down and remove the steering knuckle.

9. Installation is the reverse of these steps. Adjust the wheel bearings as described later and bleed the brakes.

Steering Knuckle Inspection

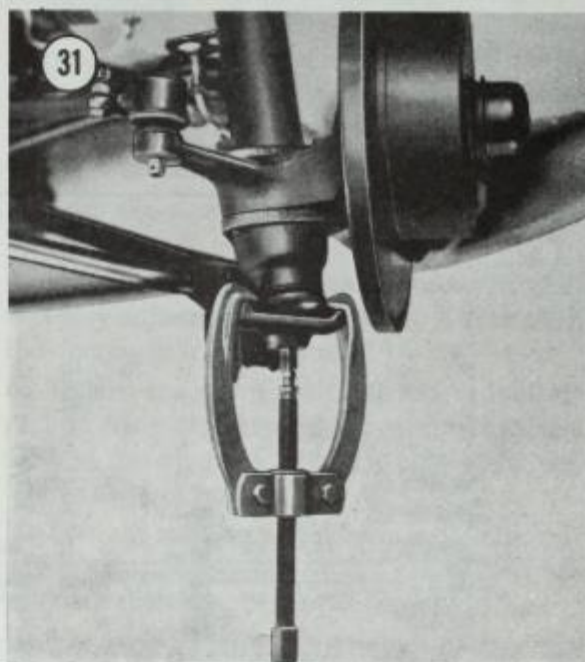
This procedure can be performed with the steering knuckle installed.

1. Check the bearing surfaces for damage such as scratches, scoring or signs of excessive heat (bluish tint).
2. Measure bearing surfaces and compare to Figure 30.
3. Visually examine the entire steering knuckle for bends, cracks or other damage. If a steering knuckle is suspect, take it to a VW dealer for testing. A large variety of special test fixtures is required.



Ball Joint Replacement

1. Raise car on jackstands and remove front wheels.
2. Remove stabilizer as described later.
3. Remove nut on bottom of ball joint.
4. Pull the control arm off the ball joint as shown in **Figure 31**.



5. Remove bolts connecting the ball joint, steering knuckle, and shock absorber. Remove the ball joint, and tie up the steering knuckle to relieve tension on the brake line.
6. Installation is the reverse of these steps. Wipe all grease away from ball joint stud before installing it. Tighten 3 bolts and the ball joint nut to 29-32.5 foot-pounds (4.0-4.5 mkg).

Track Control Arm Removal/Installation

1. Raise the front of the car on jackstands and remove both front wheels.
2. Remove the stabilizer as described later.
3. Remove the nut on the ball joint and disconnect the control arm from the ball joint as shown in **Figure 31**.
4. Make alignment marks on the control arm, eccentric bolt, and frame. Unbolt the eccentric bolt and remove the control arm.
5. Check the control arm for bends. VW recommends comparing the arm to a new one. Examine carefully for cracks and other damage.

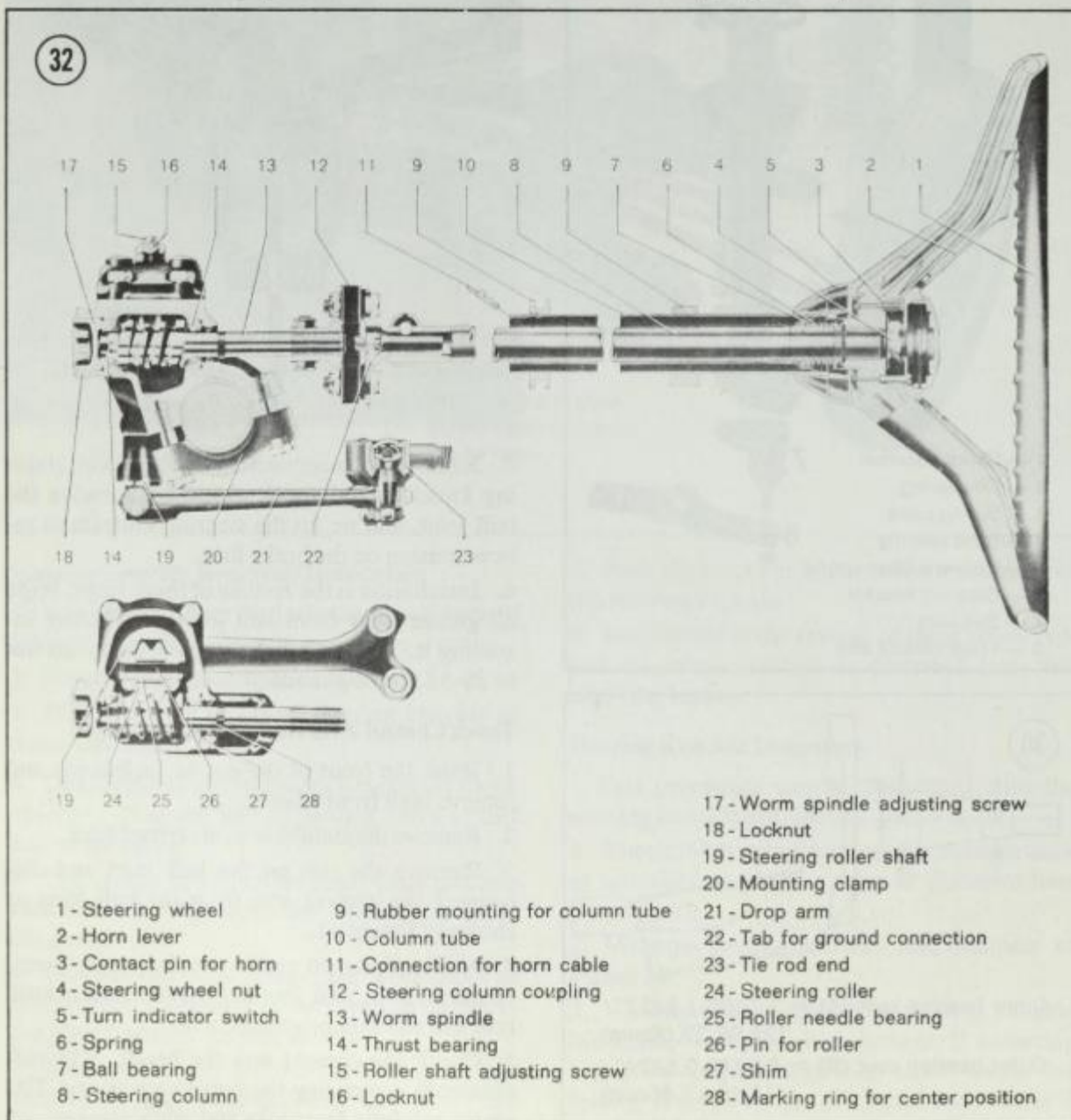
6. Installation is the reverse of these steps.
7. Check and adjust wheel camber.

STEERING

Two steering arrangements are used on all Beetles from 1961 to 1972. Figures 8 and 21 show steering for all Beetles except the Super Beetle. The steering gear is worm and roller. Motion of the pitman arm moves the steering knuckles through adjustable tie rods. A steering damper, similar to a shock absorber, lessens road shock to the steering wheel.

Figure 28 shows Super Beetle steering. The steering gear is also worm and roller. Pitman arm motion is transmitted to a center tie rod supported at one end by an idler arm. Center tie rod movement, in turn, moves the steering knuckles through 2 adjustable outer tie rods. A steering damper lessens road shock as in all other Beetles.

Three steering column designs are used. Beetles from 1961-1965 have a solid column with the steering wheel bolted on one end. The other end connects to the steering gear through a flexible coupling. See Figure 32.



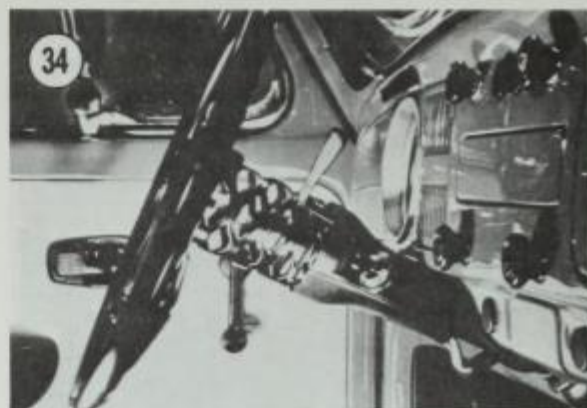
Beetles and Karmann Ghias from 1966-1971 (except Super Beetles) have a collapsible section in the steering column to protect the driver in a collision. See **Figure 33**.

Super Beetles also have a safety steering column design. The steering column is in 2 pieces connected by universal joints. When either the steering gear or steering wheel is subjected to an impact force, the small steering column shaft deflects. The impact energy, therefore, cannot be transmitted through the column to injure the driver.

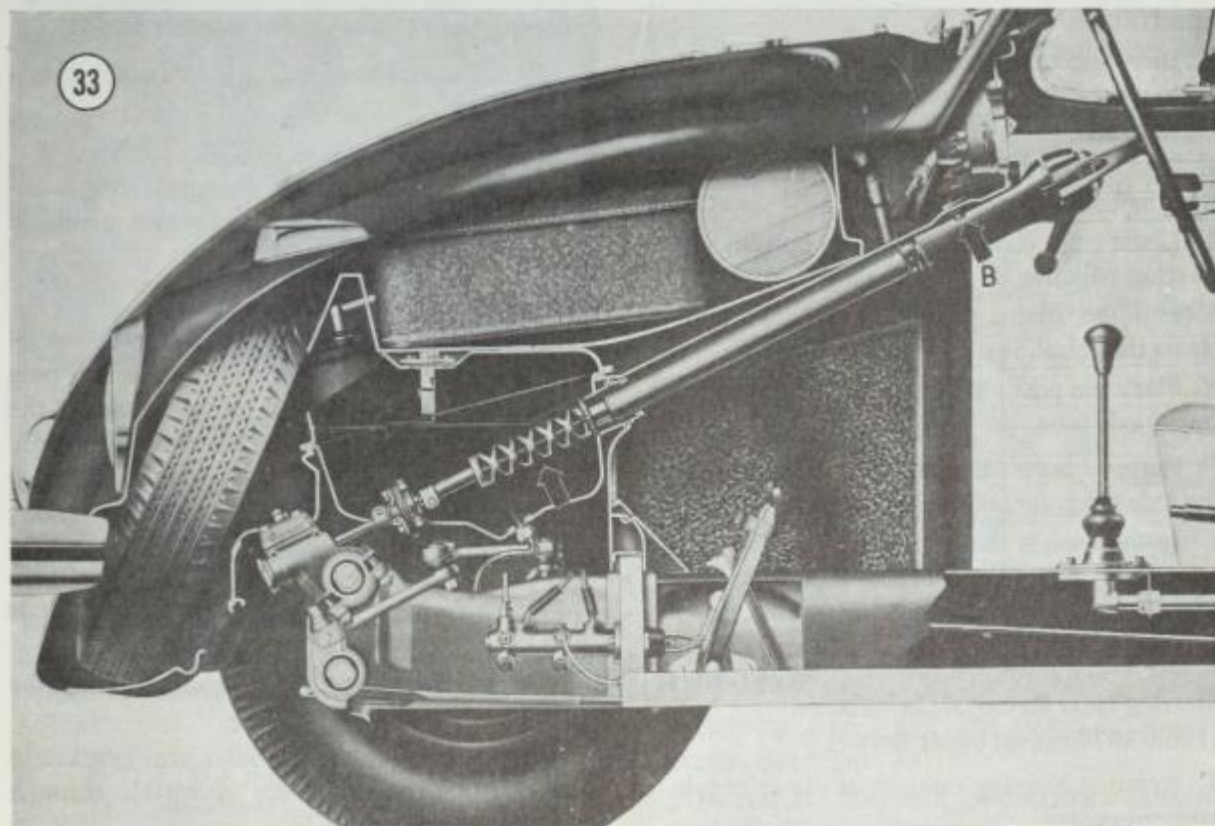
All 1972 VW's provide additional driver protection. The safety steering wheel has a collapsible section which absorbs impact energy. See **Figure 34**.

Steering Gear Adjustment

With both wheels on the ground and pointing straight ahead, move the steering wheel gently from side to side until resistance is felt. The amount of free play at the outer rim of the steering wheel should be 1" or less. If free play is more than this, the steering gear may need adjustment. First ensure that free play is not caused by loose tie rods or ball joints.



1. Raise the front of the car on jackstands.
2. Turn the steering wheel to one lock or the other.
3. Loosen the large lock nut on the worm shaft end play adjustment located at the lower end of the steering gear. See **Figure 32**.
4. Tighten the worm shaft adjustment until no play is felt when moving the worm back and forth at the coupling. Hold the adjustment and tighten the lock nut.
5. Turn the steering wheel from lock to lock. If any binding is felt, loosen the worm shaft adjustment slightly until the binding disappears.



6. Lower the car. Turn the wheels straight ahead and test free play in steering again. If free play still exceeds 1" (25mm), complete the following steps.
7. Turn the steering wheel 90° to the left or right.
8. Loosen the roller shaft adjusting screw lock nut. See Figure 32.
9. Loosen the adjusting screw one complete turn. Then, tighten the adjusting screw until you feel the roller contact the steering worm. Hold the adjusting screw and tighten the lock nut to 16-18 foot-pounds (2.2-2.5 mkg).
10. Check free play with steering turned 90° to the left, then 90° to the right. Free play should not exceed 1". If free play is greater on one side than the other, readjust as in steps 8 and 9 on the side with the greatest free play.
11. If free play with wheels straight ahead still exceeds 1", internal parts are badly worn. The steering gear must be repaired by a VW dealer.

Steering Gear Removal/Installation (1961-1967)

1. Raise car on jackstands and remove front wheels.
2. Disconnect the tie rod ends from the pitman arm on the steering gear with a special tool. See Figure 46.
3. Disconnect the horn ground wire from this steering column coupling.
4. Loosen the clamp bolt at the bottom of the steering column.
5. Pull the steering column upwards until it clears the coupling.
6. Mark the position of the steering gear on the upper axle tube.
7. Remove bolts clamping the steering gear to the axle tube and remove the steering gear.
8. Installation is the reverse of these steps. Use new lock plates under the mounting clamp screws.
9. Check and adjust toe-in.

Steering Gear Removal/Installation (1968-1972 except Super Beetle)

1. Remove steering column as described in a later procedure.

2. Mark the position of the steering gear on the upper axle tube.
3. Remove bolts clamping the steering gear to the axle tube and remove the steering gear.
4. Installation is the reverse of these steps.
5. Check and adjust toe-in.

Steering Gear Removal/Installation (Super Beetle)

1. Raise the left side of the car on jackstands and remove the left front wheel.
2. Disconnect the steering damper from the pitman arm on the steering gear.
3. Disconnect the center tie rod end from the pitman arm.
4. Slide the rubber boot off the bottom steering column universal joint. Loosen the clamp bolt and pull the universal joint off the steering gear.
5. Remove bolts securing the steering gear to the body. All bolts are accessible through the left wheel well.
6. Installation is the reverse of these steps.
7. Check and adjust toe-in.

Steering Gear Cover Gasket Replacement

1. Remove steering gear as described previously.
2. Remove steering gear cover.
3. On 1966-1972 models, top up steering housing with liquid transmission grease available from VW.
4. Install cover with new gasket.
5. Install steering gear as described previously.
6. On 1961-1965 models, remove oil filler plug from cover. Bring oil level to the bottom of the filler hole threads with SAE 90 transmission oil.

Idler Arm Removal/Installation (Super Beetle only)

1. Raise the right side of the car on jackstands and remove the right front wheel.
2. Disconnect the center tie rod end from the idler arm.
3. Remove bolts securing idler arm bracket to the body. These bolts are accessible through the right wheel well.

Steering Wheel Removal

1. Disconnect battery ground cable.
- 2a. On 1961-1971 models, carefully pry the horn cap off with a screwdriver.
- 2b. On 1972 models, pry the horn cover off at one of the spokes. See **Figure 35**.



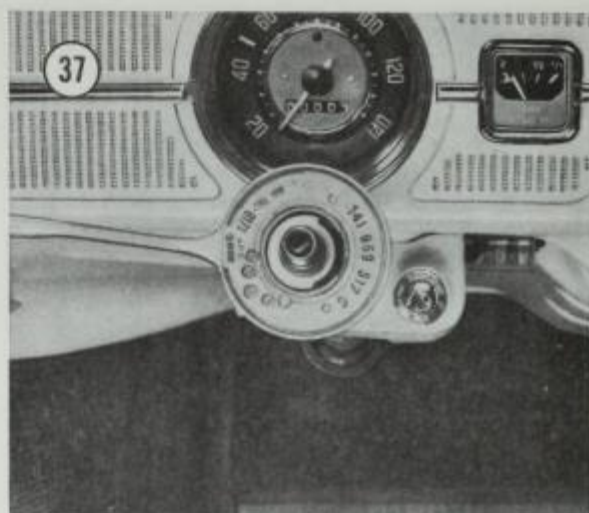
3. Disconnect the horn ground cable.
4. Remove steering wheel nut and lock washer. See **Figure 36**.
5. Remove steering wheel.



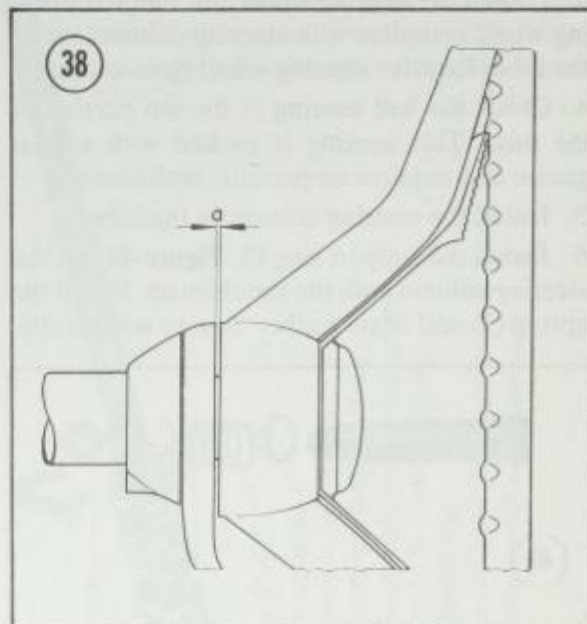
Steering Wheel Installation

1. Ensure that the brass washer for the self-canceling turn switch is positioned with the cutaway portion to the right and the front wheels straight ahead. See **Figure 37**.
2. Install the steering wheel with the spokes horizontal. The tab on the steering wheel must engage in the cutaway portion of the brass washer.

NOTE: The safety steering wheel on 1972 models may be installed on earlier models with no modifications.



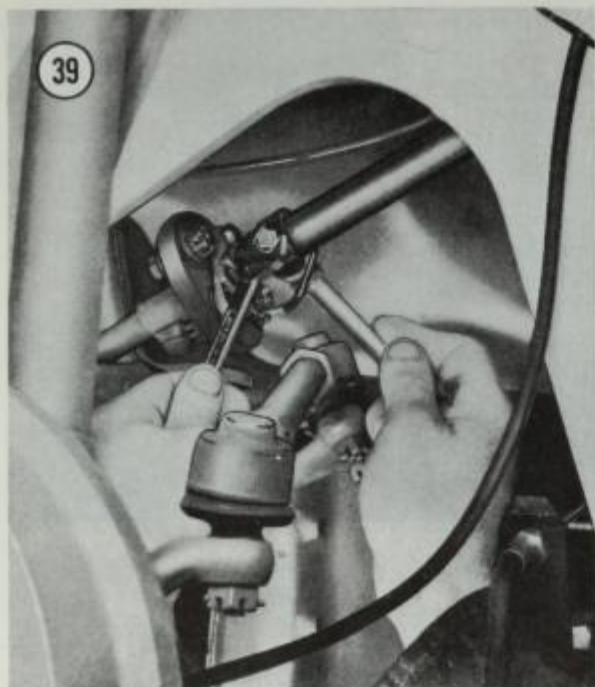
3. Install the lock washer and nut. Tighten the nut to 36 foot-pounds (5.0 mkg).
4. Check the gap at (a) in **Figure 38**. This gap should be 0.04-0.08" (1-2mm). Adjust as described in Steering Column Installation.



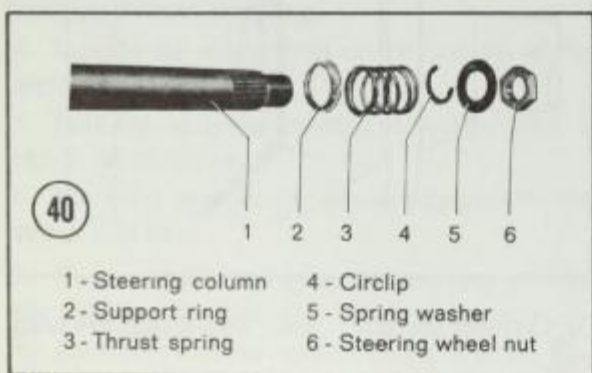
5. Connect the horn cable, and install the horn cap.
6. Connect the battery ground cable.

Steering Column Removal/Installation (1961-1967)

1. Remove clamp bolt and clamp on steering column. See **Figure 39**.
2. Disconnect the horn ground wire from the steering column coupling.



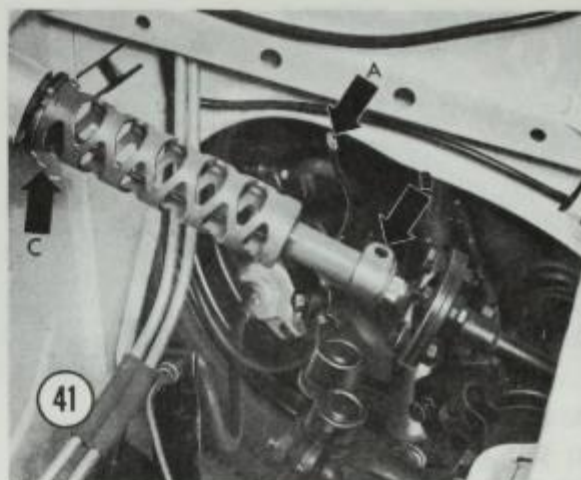
3. Loosen the steering wheel nut. Pull the steering wheel complete with steering column out of the tube. Remove steering wheel from column.
4. Check the ball bearing in the top portion of the tube. This bearing is packed with special grease and requires no periodic maintenance.
5. Install the steering column in the tube.
6. Install the support ring (2, **Figure 40**) on the steering column with the shoulder up. Install the spring (3) and brass washer. Secure with circlip.



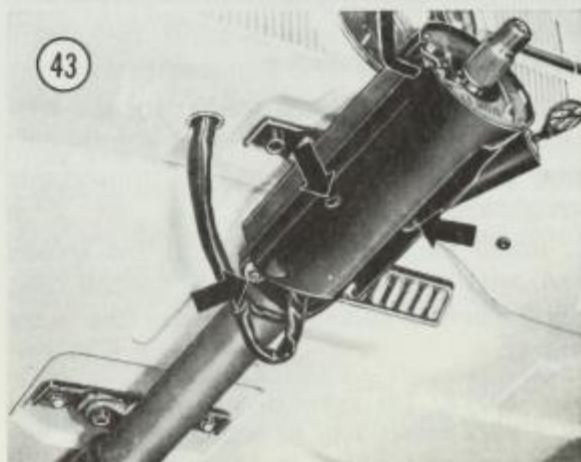
7. Install the steering wheel as described in previous procedure.
8. Set the gap shown in **Figure 38** to 0.04-0.08" (1-2mm) by moving the steering column in the coupling.
9. Install the lower clamp and tighten the clamp bolt. Use a new lock plate on the bolt.

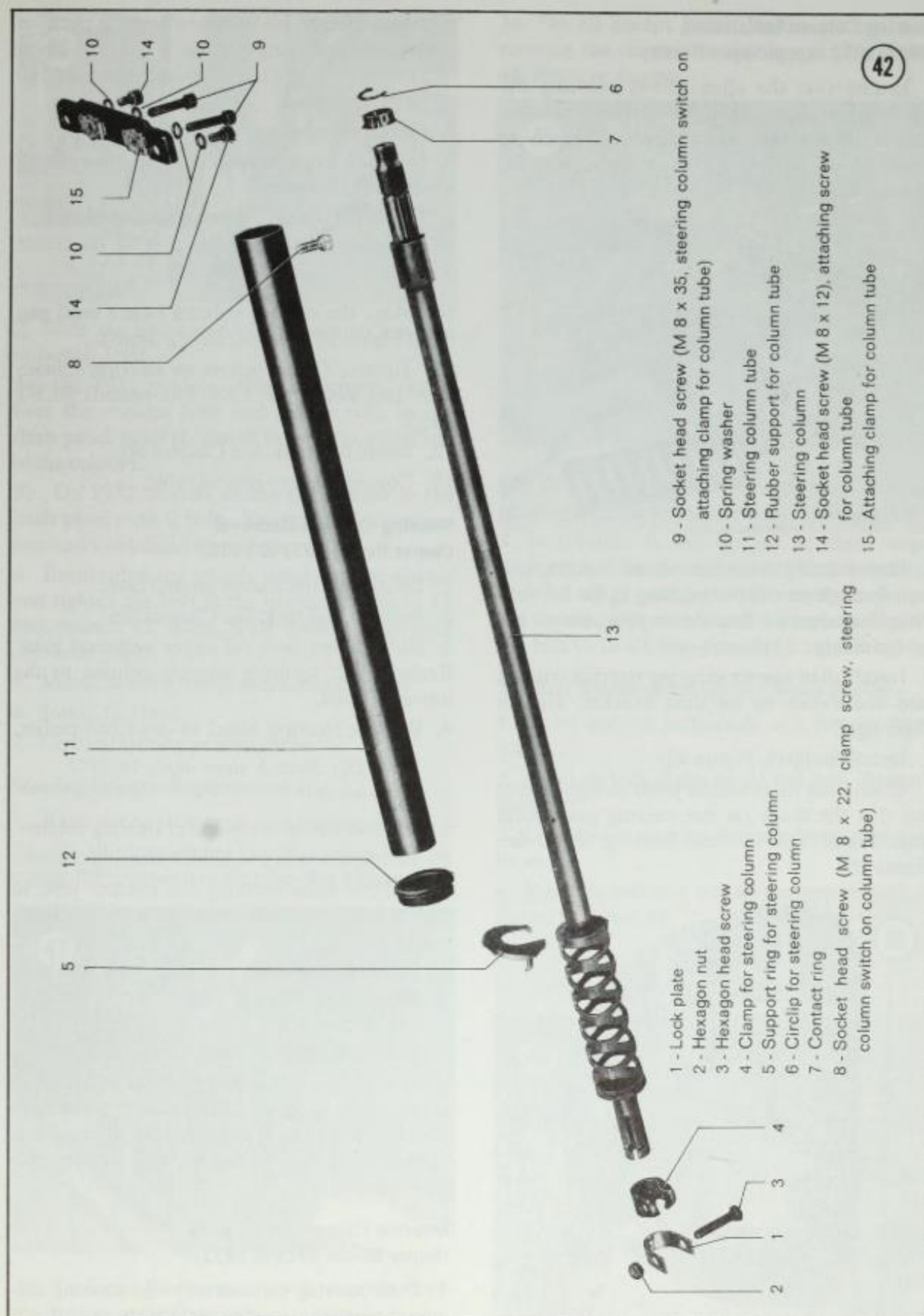
Steering Column Removal (1968-1972 except Super Beetle)

1. Disconnect battery ground cable.
2. Remove fuel tank. See Chapter Six.
3. Disconnect ground cable from steering column coupling (A, **Figure 41**).



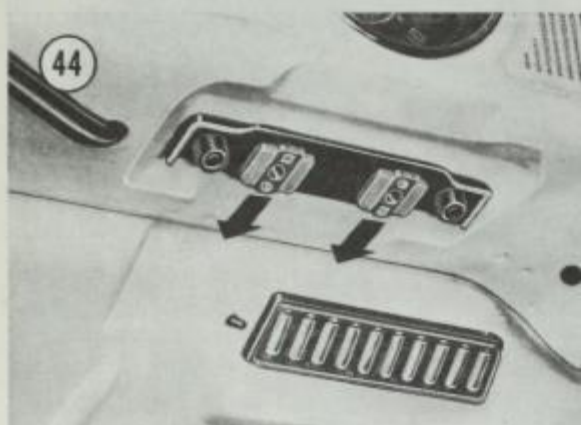
4. Remove clamp nut (B, **Figure 41**).
5. Bend up support ring tabs and remove the support ring (C, **Figure 41** or 5, **Figure 42**).
6. Remove steering wheel as described in an earlier procedure.
7. Remove the steering column circlip (6, **Figure 42**).
8. Turn ignition key to unlock steering column.
9. Remove 3 allen screws securing steering column tube and steering columns switch. See **Figure 43**. Take switch off column and hang it so there is no tension on wires.
10. Pull steering column and tube upwards and out.





Steering Column Installation (1968-1972 except Super Beetle)

1. Ensure that the allen screws securing the mounting bracket are tight and that the open ends of the slots holding the threaded aluminum inserts faces towards the front. See arrows in Figure 44.

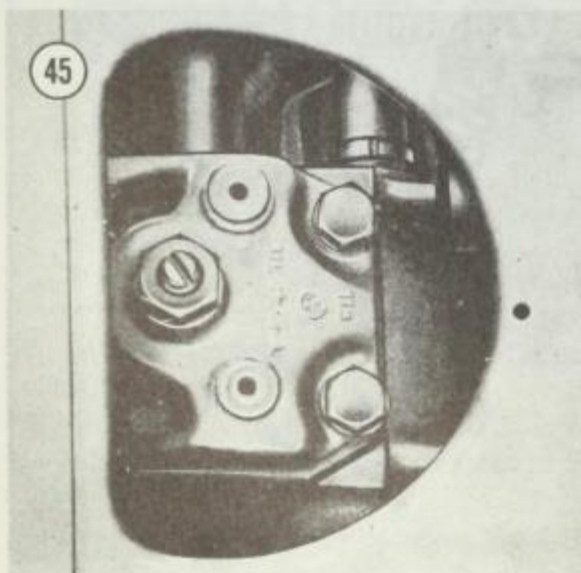


2. Push steering column tube and steering column through the rubber bushing in the firewall. Fit column over the flexible coupling, but do not tighten clamp.

3. Install allen screws securing steering column tube and switch to the dash bracket. Tighten finger tight.

4. Install circlip (6, Figure 42).

5. Check that front wheels point straight ahead and that the mark on the steering gear worm shaft aligns with the cast housing seam. See Figure 45.



6. Install clamp bolt with new locking plate on lower end of steering column. Tighten the bolt to 11 foot-pounds (1.5 mkg) and bend the tab up on the lock plate.

7. Connect horn ground to coupling.

8. Install steering support ring and secure by bending the tabs over.

9. Install the steering wheel as described earlier. Ensure that turn signal lever is in its center position.

10. Move the steering column switch until gap (a) in Figure 38 is 0.08-0.12" (2-3mm).

11. Tighten 3 allen screws on steering column tube and switch to 3.5-7 foot-pounds (0.5-1 mkg).

12. Install fuel tank. See Chapter Six.

13. Connect battery ground cable.

Steering Column Removal (Super Beetle 1971 & 1972)

1. Disconnect the battery ground cable.

2. Remove fuel tank. See Chapter Six.

3. Slide rubber boot off upper universal joint. Remove bolt securing steering column to the universal joint.

4. Remove steering wheel as described earlier.

NOTE: Next 5 steps apply to 1971 models only.

5. Remove circlip at top end of steering column.

6. Turn ignition key to unlock steering column.

7. Remove bolts securing the column tube to the dash. Remove allen screws securing column switch.

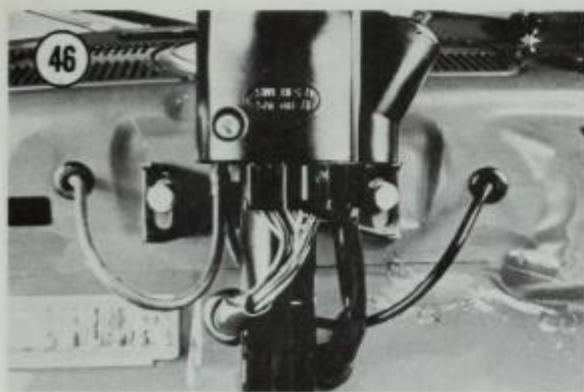
8. Remove switch from column tube and hang it with wire so there is no tension on the connecting wires.

9. Pull steering column and tube up and out.

10. On 1972 models, remove bolts securing the column tube to the dash. Disconnect connectors and windshield washer hose from steering column housing. See Figure 46. Lift steering column assembly out.

Steering Column Installation (Super Beetle 1971 & 1972)

1. Push steering column tube and steering column through the opening in the body.



2. Slide the lower end of the column into the universal joint.

3a. On 1971 models, slide the column switch over the column tube and secure both to the dash panel bracket. Install the circlip at the top of the column.

3b. On 1972 models, secure the column to the dash panel with 2 bolts. Reconnect the connectors and windshield wiper hose.

4. Ensure that the wheels point straight ahead, and tighten the bolt in the universal joint to 14 foot-pounds (2 mkg). Slide rubber boot over universal joint.

5. Install steering wheel as described earlier.

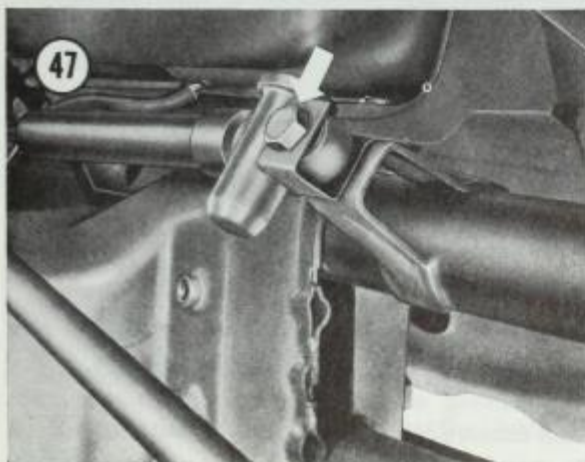
6. Install fuel tank.

7. Connect battery ground cable.

Steering Damper Replacement

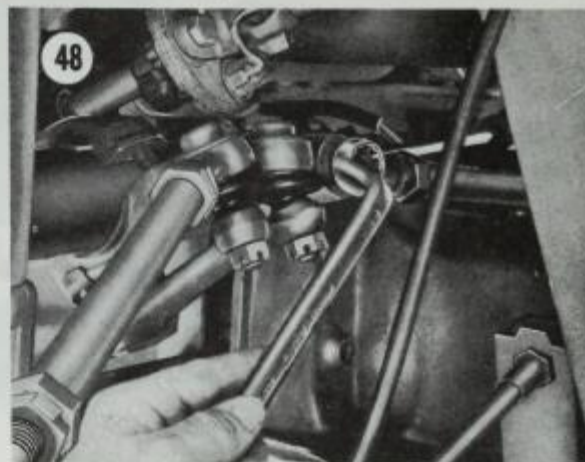
1. Raise car on jackstands and remove wheels.

2a. On all except Super Beetle, remove bolt securing the damper to axle tube. See **Figure 47**.



2b. On Super Beetle remove bolt securing steering damper to the floor pan.

3a. On all except Super Beetle, remove nuts securing the damper to the tie rod. See **Figure 48**. Remove damper.



3b. On Super Beetle, remove bolt securing steering damper to drop arm on steering gear.

4. Installation is the reverse of these steps. Tighten nut on tie rod to 18-22 foot-pounds (2.5-3.5 mkg) and secure with lock nut. Install the bracket bolt with a new lock plate. Tighten the bolt to 18-21 foot-pounds (2.5-3.0 mkg).

Tie Rod Replacement (except Super Beetle)

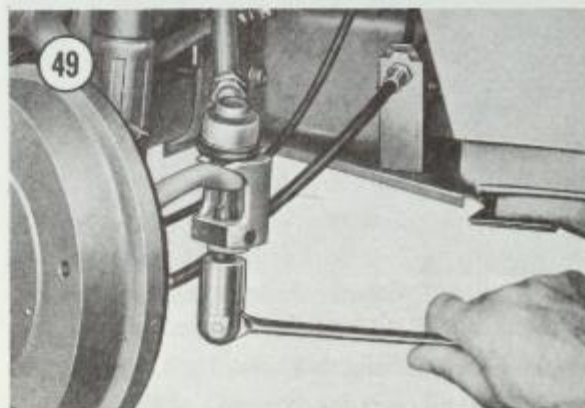
1. Raise car on jackstands and remove front wheels.

2. Bend up lock plates on tie rod nuts. Remove the nuts.

3. Disconnect steering damper from right side tie rod.

4. Press tie rod end out with a special tool as shown in **Figure 49**.

CAUTION: Do not damage rubber seals when removing tie rods.



5. Check tie rods for bends and other damage. Bent tie rods must be replaced, not straightened.
6. Check tie rod pin. If there is any play or the pin is frozen, the tie rod end must be replaced.
7. Check rubber seals. Damaged seals must be replaced.
8. Check steering damper bushing for wear. Replace if necessary.
9. Install all tie rods so the end with left-hand threads is towards the left side of the car.
10. Connect steering damper to tie rod.
11. Adjust toe-in.

Tie Rod Replacement (Super Beetle)

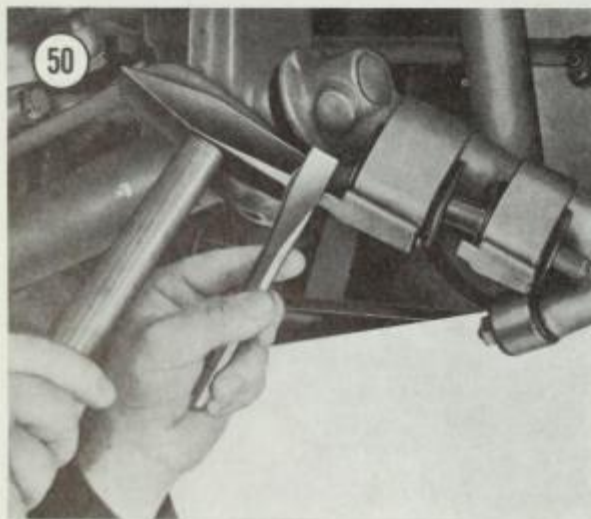
Outer tie rod replacement on the Super Beetles is identical to that described for other Beetles, except that the steering damper need not be disconnected.

Center tie rod replacement is the same as for any other tie rod. However, the outer tie rods should first be disconnected from the center tie rod.

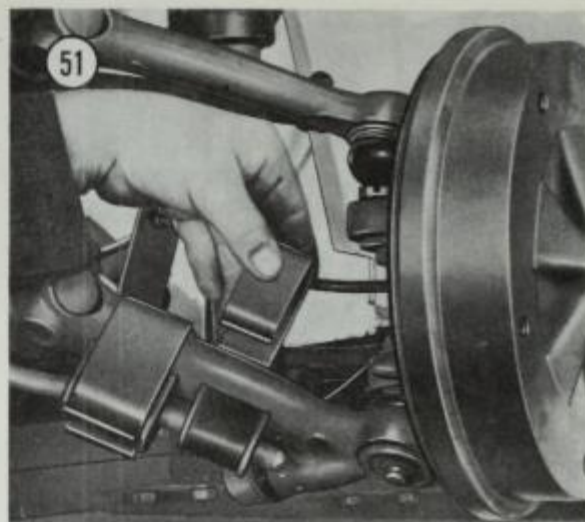
STABILIZER

Removal/Installation (except Super Beetle)

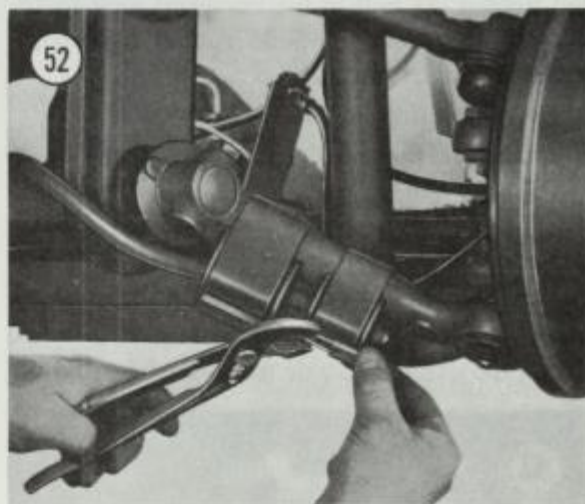
1. Raise the car on jackstands and remove both front wheels.
2. Bend the lugs up on the clips and tap the clips off the damper as shown in **Figure 50**.



3. Remove the clamps. See **Figure 51**.
4. Pull the stabilizer out.
5. Inspect all parts for damage.



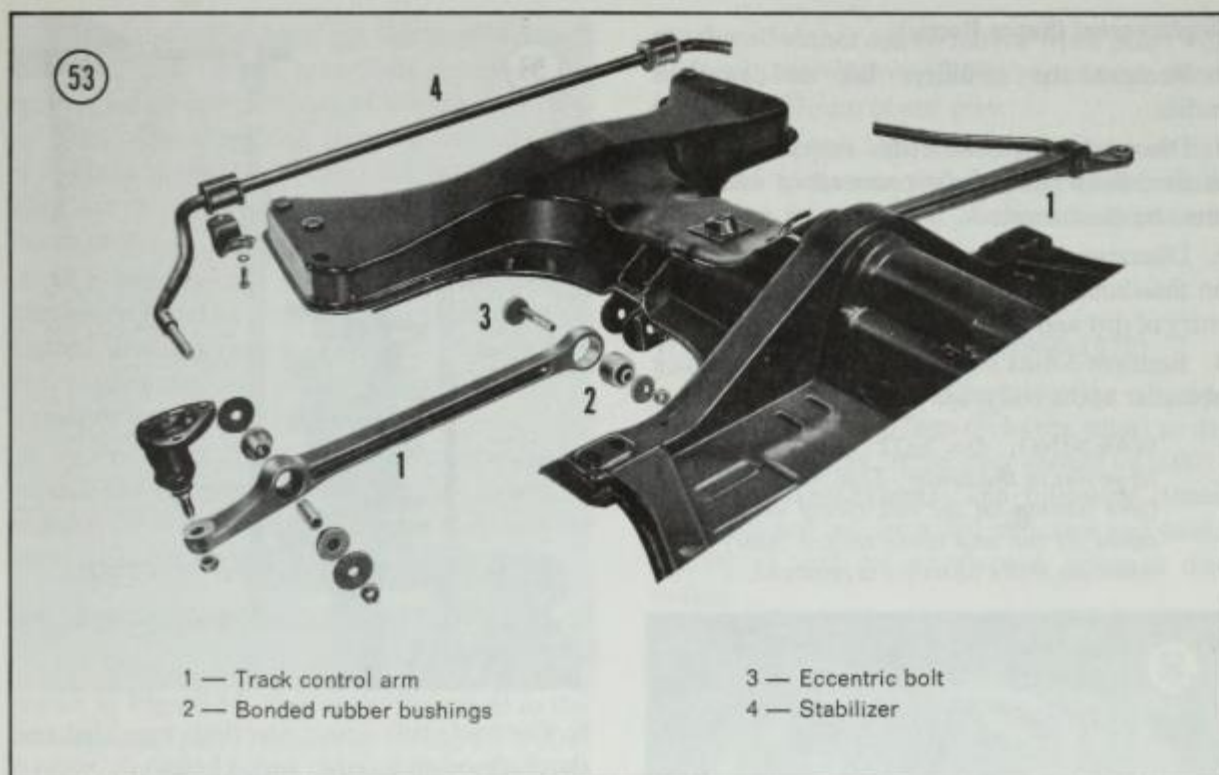
6. Reinsert stabilizer into rubber bushings.
7. Install the clamps with the slot tapering toward the steering knuckle.
8. Compress the clamps with water pump pliers and slide the clips on. See **Figure 52**. Bend the lugs to secure them.



Removal/Installation (Super Beetle)

Refer to **Figure 53** for the following procedure.

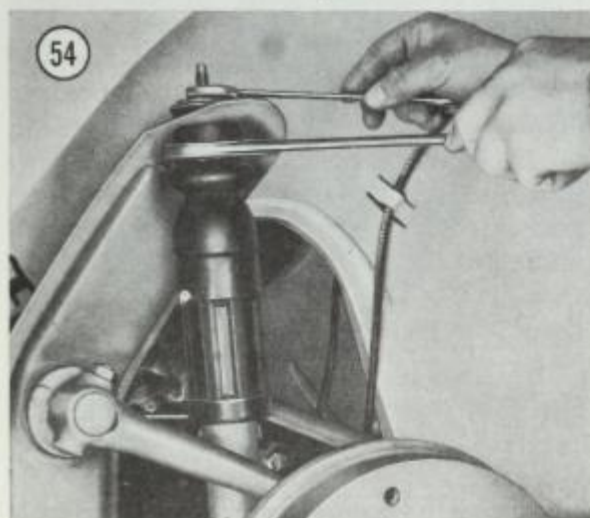
1. Raise front of car on jackstands.
2. Remove nuts and washers securing the stabilizer to the track control arms.
3. Remove screws securing the front clamps and remove clamps.
4. Pull the stabilizer out of the track control arms.
5. Installation is the reverse of these steps.



SHOCK ABSORBERS

Replacement (except Super Beetle)

1. Raise the front of the car on jackstands and remove both front wheels.
2. Remove upper nut while holding the bottom of the stud as shown in **Figure 54**.



3. Remove the bottom nut securing the shock absorber.
4. Remove the shock absorber.
5. Grease the lower mounting pin lightly.

6. Install the shock absorber and nut on the lower pin.

7. Slide a rubber bushing on the top stud with the shoulder facing up. See **Figure 55**.



8. Pull the top stud up until it passes through the upper mounting hole.

9. Install another rubber bushing with the shoulder facing down.

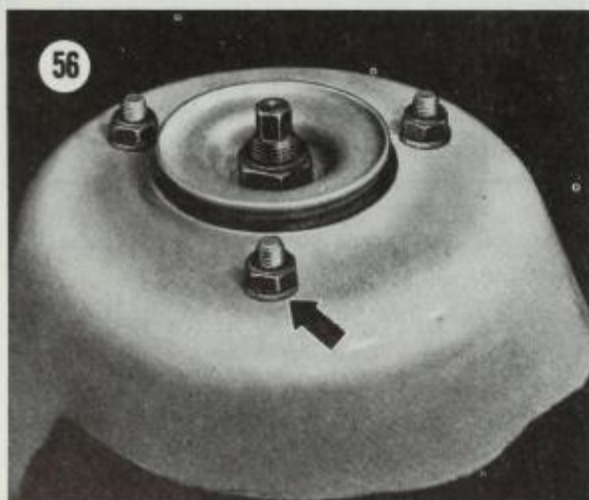
10. Install the washer. Install the nut and tighten down as far as it goes.

11. Tighten the lower nut to 22-25 foot-pounds (3.0-3.5 mkg).

Replacement (Super Beetle)

1. Remove the stabilizer bar as described earlier.
2. Disconnect tie rods from steering knuckle as described later. Only one end of each rod must be disconnected.
3. Disconnect the brake line from its bracket on the shock absorber. Plug the line to prevent entry of dirt and water vapor.
4. Remove 3 nuts securing the top of the shock absorber to the body. See **Figure 56**.

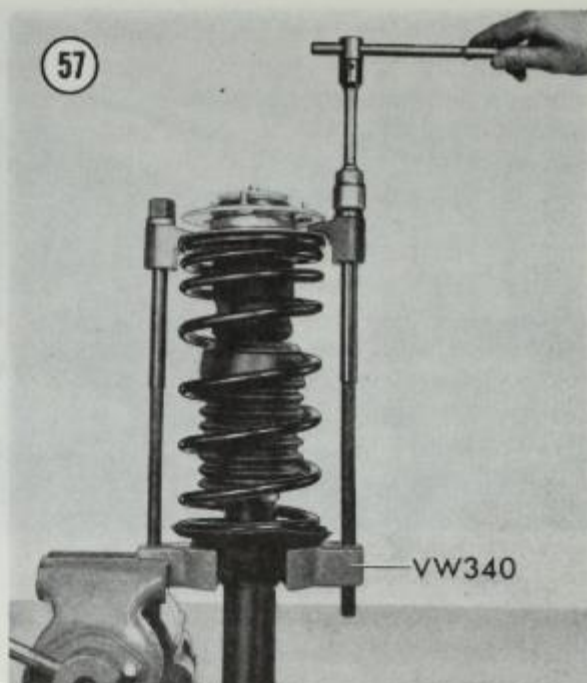
WARNING: Do NOT remove the large nut in the center. This would relieve tension on the coil spring which could fly out and cause serious injury when the shock absorber is removed.



5. Remove 3 bolts securing the bottom of the shock absorber to the steering knuckle and ball joint. See **Figure 29**. Push the track control arm down and lift the shock absorber out.

NOTE: The following 2 steps are impossible without a spring compressor. Take the shock absorbers to a VW dealer and let him transfer the coil spring from old to new shock absorbers.

6. Compress the spring with a special tool as shown in **Figure 57**. Remove the center nut on top of the shock absorber. Release spring tension slowly and disassemble the shock absorber.
7. Reassemble the spring and rubber parts on the shock absorber. Compress the spring, install the top plate, and secure with the large nut. Release spring tension.



8. Connect ball joint, steering knuckle, and shock absorber together with 3 bolts.
9. Lift the upper part of the shock into the upper mounting holes. Install 3 nuts.
10. Reconnect tie rod ends.
11. Install stabilizer bar.
12. Reconnect brake line and bleed the brakes.

COIL SPRING REPLACEMENT

The coil spring is part of the shock absorber assembly. To replace the spring, follow the shock absorber procedure. Since the procedure requires a special tool, it is best to remove the shock absorber assembly following the procedure, and let a VW dealer replace the spring. Then install the assembly following the same procedure.

WHEEL BEARINGS

Two types of wheel bearings are used from 1961 to 1972. Ball bearings are used in king pin suspension cars (1961-1965), while tapered roller bearings are used in later cars (1966-1972). Adjustment procedures vary slightly for each type.

Wheel Bearing Replacement

1. Remove brake drums and wheel bearings as described in Chapter Twelve.

2. Clean the wheel bearings thoroughly in solvent and blow dry. Check balls or rollers for scores, wear, and evidence of overheating (bluish tint). Check bearing races on the axle stub and brake drum. Do not mix the bearings up if they are good; they must be replaced on the same race.

3. If a bearing or a bearing race is damaged, the bearing and both bearing races must be replaced. Bearing race replacement requires special equipment and must be done by a VW dealer or front end repair shop.

4. If necessary to drive the car to a repair shop, repack the bearings and adjust them as well as possible. See Front Brake Drum Installation for steps describing wheel bearing packing.

Wheel Bearing Adjustment (1961-1965)

VW attaches a dial indicator to the wheel as shown in **Figure 58**, then rocks the wheel to determine axial play. Axial play should be 0.001-0.005" (0.03-0.12mm). The following procedure does not require a dial indicator and works equally as well if you are careful.



1. Remove the outer hub nut and lock plate.
2. Now tighten the inner nut to about 15 foot-pounds (2 mkg) while rotating the wheel. This takes all slack out of the bearings.
3. Loosen the inner nut just to the point where

the thrust washer can be moved when pried with a large screwdriver. This represents about 0.001" (0.03mm) of end play.

4. Install a new lock plate and outer hub nut. Hold the inner nut with a thin wrench while tightening the outer nut or the adjustment will change.

5. Bend the lock plate tabs to secure the nuts.

Wheel Bearing Adjustment (1966-1972)

VW attaches a dial indicator on the wheel as shown in **Figure 58**, then rocks the wheel to determine axial play. Axial play should be 0.001-0.005" (0.03-0.12mm). The following procedure does not require a dial indicator and works equally as well for wheels with drum or disc brakes.

1. Loosen screw in clamp nut.
2. Tighten the clamp nut to about 15 foot-pounds (2 mkg) while rotating the wheel. This takes all slack out of the bearing.
3. Loosen the clamp nut just to the point where the thrust washer can be moved when pried with a screwdriver. Loosen the nut an additional 1/12 turn (1/2 flat on the hex).
4. Tighten the clamp screw to 7-9 foot-pounds (1-1.3 mkg) and check the thrust washer with a screwdriver. If it is very loose, repeat the entire procedure.

NOTE: When the axial play is near 0.005" (0.12mm), very slight axial play can be felt when rocking the wheel by hand. This is permissible as long as the bearings are not noisy.

Table 1 TIGHTENING TORQUES

	foot-pounds	mkg
All except Super Beetle		
Front axle to frame	36	5.0
Shock absorber (upper)	14	2.0
Shock absorber (lower)	22-25	3.0-3.5
Ball joint nuts (M10x1)	29-36	4.0-5.0
Ball joint nuts (M12x1.5)	36-50	5.0-7.0
Tie rod nuts	22	3.0
Steering damper nut	18	2.5
Steering damper bolt	29-32	4.0-4.5
Torsion bar setscrew	29-36	4.0-5.0
Torsion bar locknut	29-36	4.0-5.0
Pitman arm nut	50	7.0

Table 1 TIGHTENING TORQUES (Continued)

	foot-pounds	mkg		foot-pounds	mkg
Super Beetle					
Track control arm nut	29	4.0	Steering gear to axle	18-22	2.5-3.0
Ball joint nut	29	4.0	Roller shaft adj. lock nut	18	2.5
Stabilizer to track control arm	22	3.0	Steering worm adj. lock nut	36-43	5.0-6.0
Stabilizer clamp to frame	14	2.0	Steering gear cover bolts	14-18	2.0-2.5
Strut to body nuts	14	2.0	Pitman arm nut	72	10.0
Strut to shock absorber	50-61	7.0-8.5	Steering wheel nut	36	5.0
Steering knuckle to ball joints bolts	29	4.0	Steering coupling	14-18	2.0-2.5
Idler arm bracket to body	22	3.0	Steering column mounting bolts	11	1.5
Idler arm to bracket	29	4.0	Steering U-joint bolts	18	2.5

Table 2 SPECIFICATIONS

	1961-1965	1966-1972 (except Super Beetle)	1971-1972 Super Beetle
WHEEL ALIGNMENT			
Toe-in (no pressure on wheels)	+30' ±15'	+30' ±15'	+30' ±10'
Toe-in (with pressure on wheels)	+5' ±15'	+5' ±15'	+10' ±10'
Pressure applied for above spec.	22±4 lbs (10±2 kg)	22±4 lbs (10±2 kg)	22±4 lbs (10±2 kg)
Max. permissible difference in toe-in specs. above	25'	25'	25'
Castor	3° 20' ±1°	3° 20' ±1°	2° ±35'
Camber	+30' ±20'	0° 30' ±20'	1° 20' ±20'
Steering axis inclination	5°	5°	8° 15'
Toe-out on turns (at full left or right lock)			
inner wheel	34° ±2°	34° ±2°	40°
outer wheel	28° ±1°	28° ±1°	35°
STEERING GEAR			
Turns lock-to-lock	2½	2½	2¾
Steering ratio	14.34, 14.14 ¹	14.34, 14.14 ¹	16.5
Free-play (measured at outer edge of steering wheel)	1" (25mm)	1" (25mm)	1" (25mm)

¹ Karmann Ghia

CHAPTER TWELVE

BRAKES

Volkswagen uses conventional hydraulically operated brakes on all 4 wheels. Beetles and Karmann Ghias from 1961-1966 use a single circuit hydraulic system which operates both front and rear brakes. Both models from 1967-1972 use a dual circuit hydraulic system. One circuit operates front brakes, while the other circuit operates the rear brakes. In addition, Karmann Ghias and some European Beetles from 1967-1972 have front disc brakes. All systems operate in a similar manner. Specifications are at the end of the chapter.

The driver depresses the brake pedal which operates a master cylinder piston through a pushrod. See **Figure 1**. Hydraulic pressure developed in the master cylinder expands the wheel cylinders in each wheel, forcing the brake shoes to contact the brake drums. Hydraulic pressure also closes the brake light switch mounted in the end of the master cylinder.

The dual circuit brakes shown in **Figure 2** work similarly. The master cylinder has 2 independent pressure circuits. When the pedal is depressed, pressure in the front half of the master cylinder operates both front wheel brakes; pressure from the rear half operates both rear wheel brakes. If one circuit should fail, the other circuit remains intact permitting a safe stop with 2 wheels.

A warning circuit incorporated in 1968-72 master cylinders tells the driver that pressure in one circuit is defective. Increased pedal travel and decreased braking also indicate trouble.

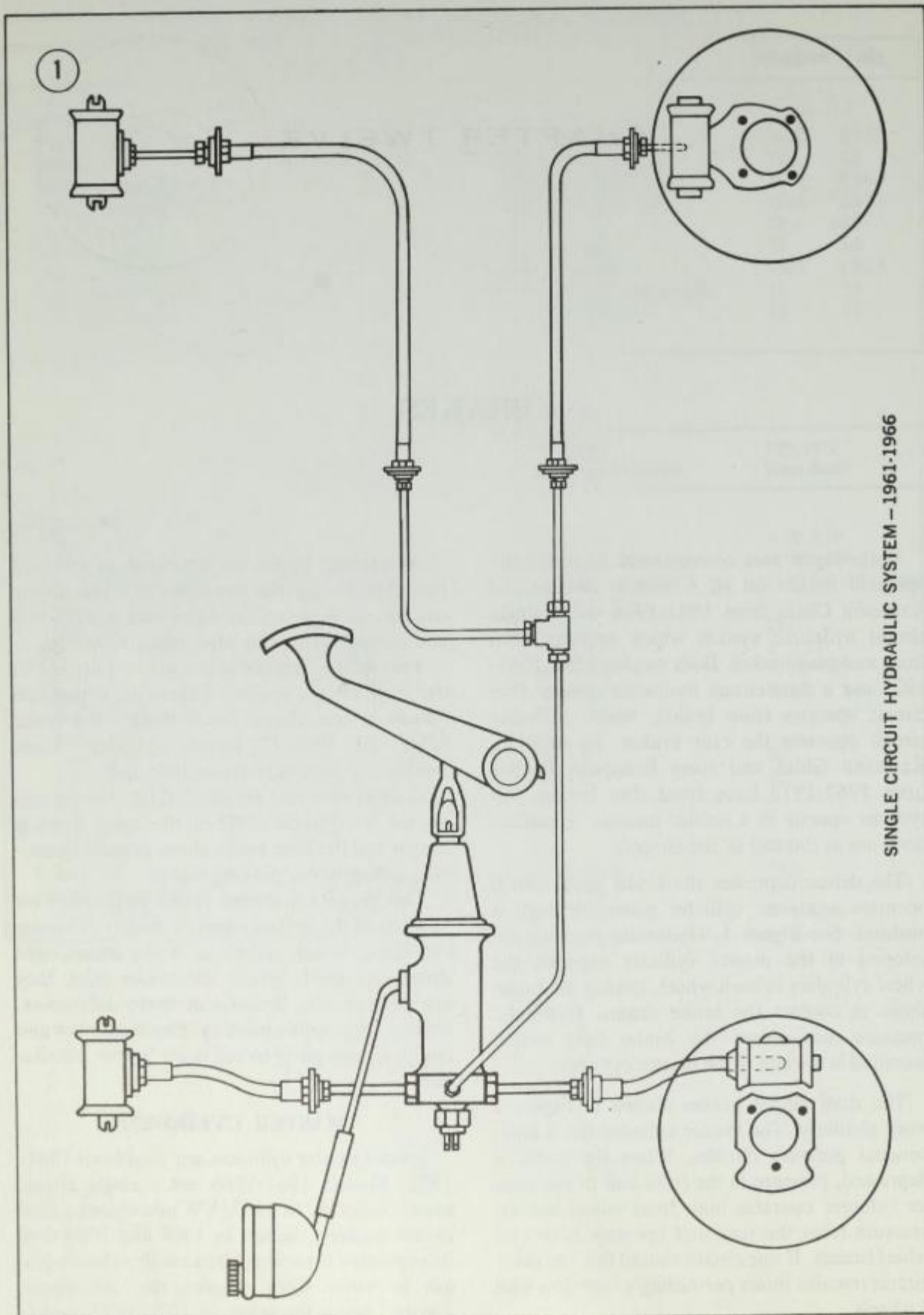
Two brake light switches are required with the dual circuit system. Otherwise a pressure failure in one circuit could disable the brake lights. In 1968-72 master cylinders, these switches operate the warning light also.

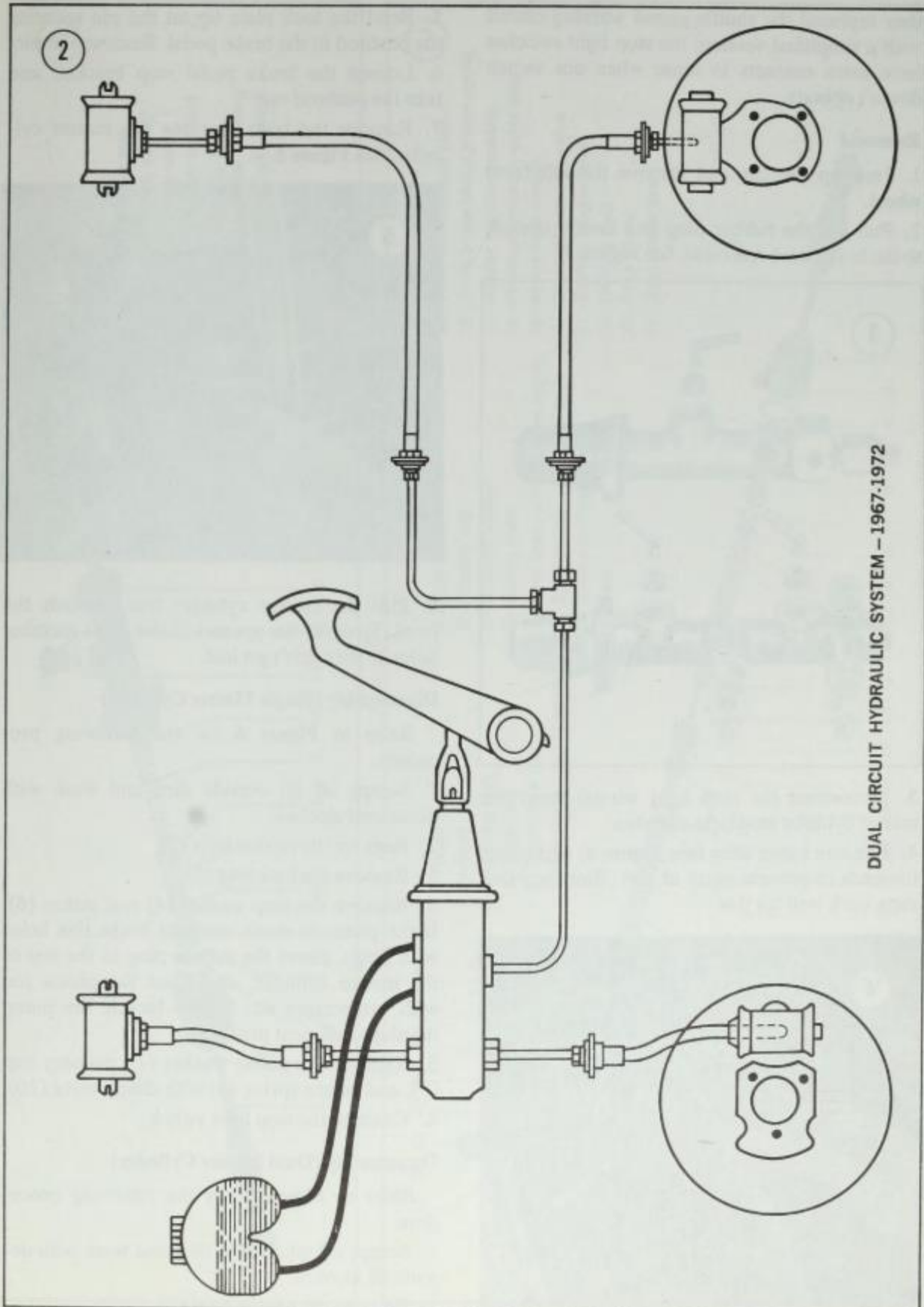
A cable-operated mechanical hand brake acts on the rear wheels. When the hand lever is drawn up, the rear brake shoes expand to provide emergency or parking brakes.

This chapter describes repair procedures for all parts of the brake system. A variety of master cylinders, wheel cylinders, brake shoes, and drums are used. Where differences exist, they are pointed out. Because of these differences, **always** order brake parts by chassis number and compare new parts to old parts before installation.

MASTER CYLINDER

Several master cylinders are used from 1961-1972. Models 1961-1966 use a single circuit master cylinder. In 1967, VW introduced a dual circuit master cylinder. In 1968 and 1969 they incorporated a warning circuit with a shuttle piston to sense when pressure in one circuit dropped below the other. In 1970-1972 models

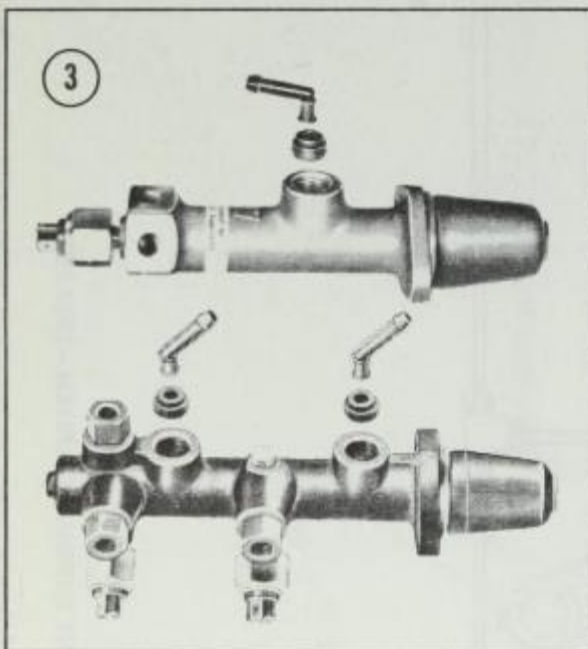




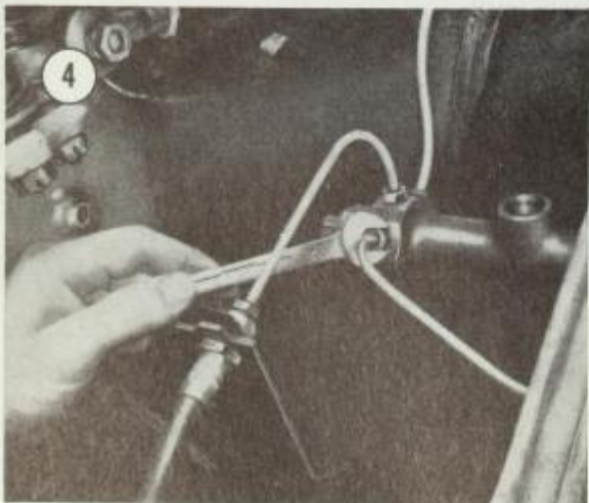
they replaced the shuttle piston warning circuit with a simplified version; the stop light switches have extra contacts to sense when one switch doesn't operate.

Removal

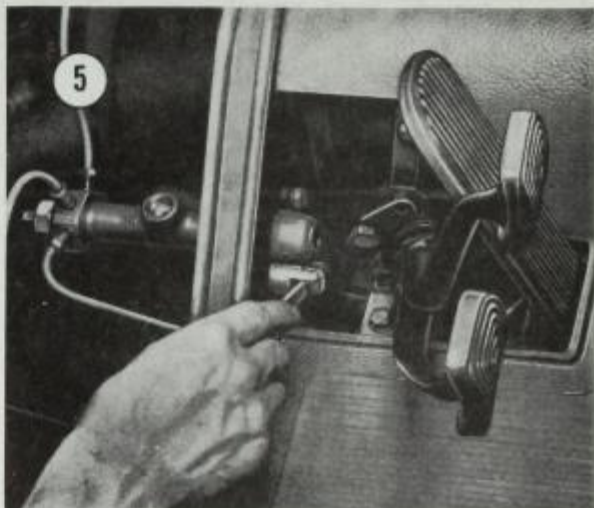
1. Jack up the car and remove the left front wheel.
2. Pull out the rubber plug and line(s) leading to the brake fluid reservoir. See **Figure 3**.



3. Disconnect the stop light wire(s) from the master cylinder stop light switches.
4. Remove brake lines (see **Figure 4**) and cover the ends to prevent entry of dirt. Bleeder valve caps work well for this.



5. Bend the lock plate up on the pin securing the pushrod to the brake pedal. Remove the pin.
6. Loosen the brake pedal stop bracket, and take the pushrod out.
7. Remove the bolts securing the master cylinder. See **Figure 5**.



8. Pull the master cylinder free towards the front. Remove the spacers in the cross member holes so they don't get lost.

Disassembly (Single Master Cylinder)

Refer to **Figure 6** for the following procedure.

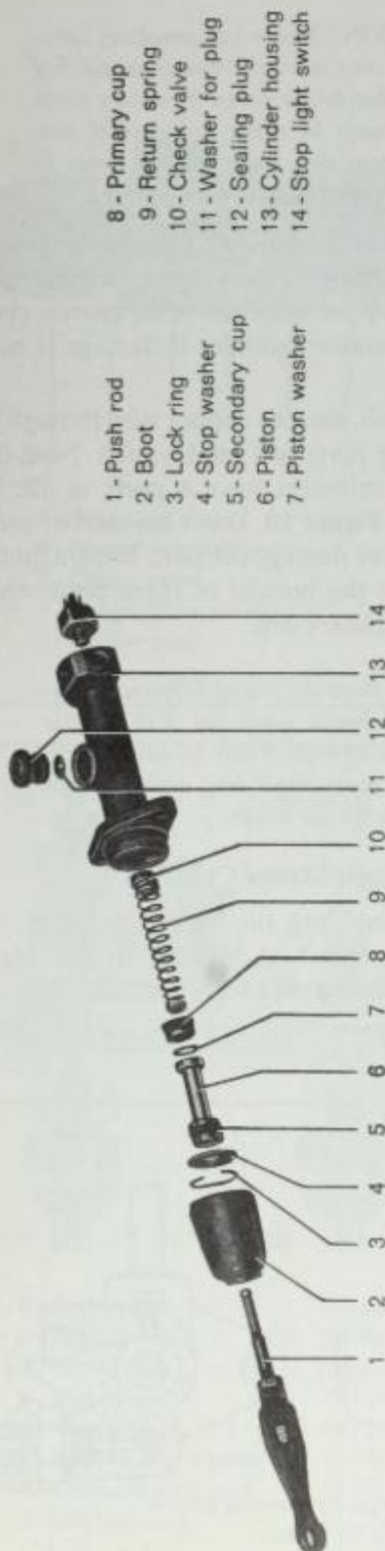
1. Scrape off all outside dirt, and wash with denatured alcohol.
2. Remove the rubber boot (2).
3. Remove the lock ring (3).
4. Remove the stop washer (4) and piston (6). If the piston is stuck, seal the brake line holes with plugs, insert the rubber plug in the top of the master cylinder, and force the piston out with compressed air. Even a bicycle tire pump develops sufficient pressure.
5. Remove the piston washer (7), primary cup (8), and return spring (9) with check valve (10).
6. Unscrew the stop light switch.

Disassembly (Dual Master Cylinder)

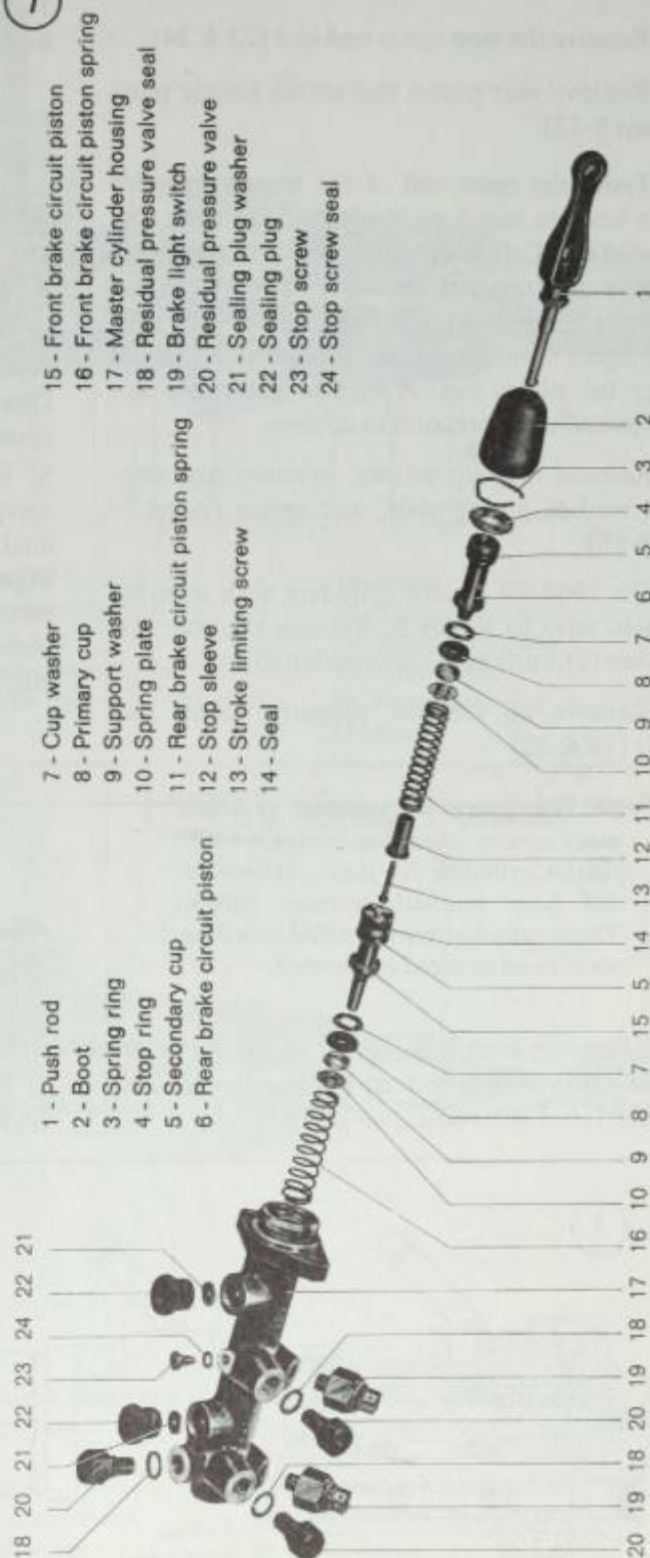
Refer to **Figure 7** for the following procedure.

1. Scrape off all outside dirt, and wash with denatured alcohol.
2. Remove the rubber boot (2).

6



7



3. Remove the lock ring (3) and stop washer (4).
4. Remove the stop screw and seal (23 & 24).
5. Remove rear piston and stroke limiter parts (items 5-13).
6. Tamp the open end of the master cylinder on a wooden bench or block, and the front piston (15) will slide out. If it sticks in the bore, remove the residual pressure valves (20) and plug the holes. Insert the front rubber plug (22) and inject compressed air through this plug to force the piston out. A bicycle tire pump develops sufficient pressure to do this.
7. Remove the cup washer, primary cup, support washer, spring plate, and spring (items 7-10 & 16).
8. On 1968-69 master cylinders with warning switch, refer to **Figure 8**. Remove the plug (1), washer (2), springs (3), and piston (5).
9. Remove all residual pressure valves and seals (18 & 20).

NOTE: Since no residual pressure must remain when disc brakes are off, master cylinders for these systems do not have residual pressure valves. These cylinders are identified by a blue vinyl band as noted in Figure 3.

10. Remove both stop light switches (19). On 1968-69 master cylinders, remove the warning switch (see Figure 8).

Inspection

1. Clean all parts in denatured alcohol or clean brake fluid.

CAUTION: Never use gasoline, kerosene or any solvent other than alcohol for rubber brake parts. You may wash metal parts in other solvents if you blow them dry, rinse several times in clean alcohol and blow dry again.

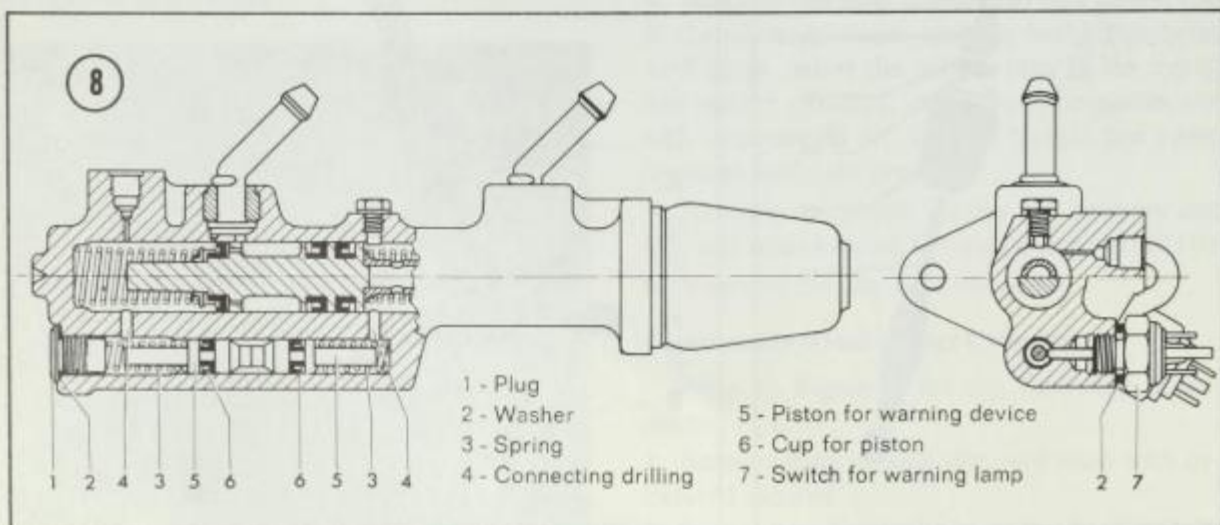
2. Inspect the cylinder bore for scoring, pitting, or heavy corrosion. Very light scratches and corrosion may be removed with **crocus cloth**. Discard the master cylinder if damage is more severe.
3. Run a small, smooth copper wire through the compensating ports and intake ports. Note that dual master cylinders have 4 ports in all. See **Figure 9** and **Figure 10**. Don't use steel or rough wire which may damage the port. Ensure that no burrs exist at the bottom of these ports which may cut the primary cup.

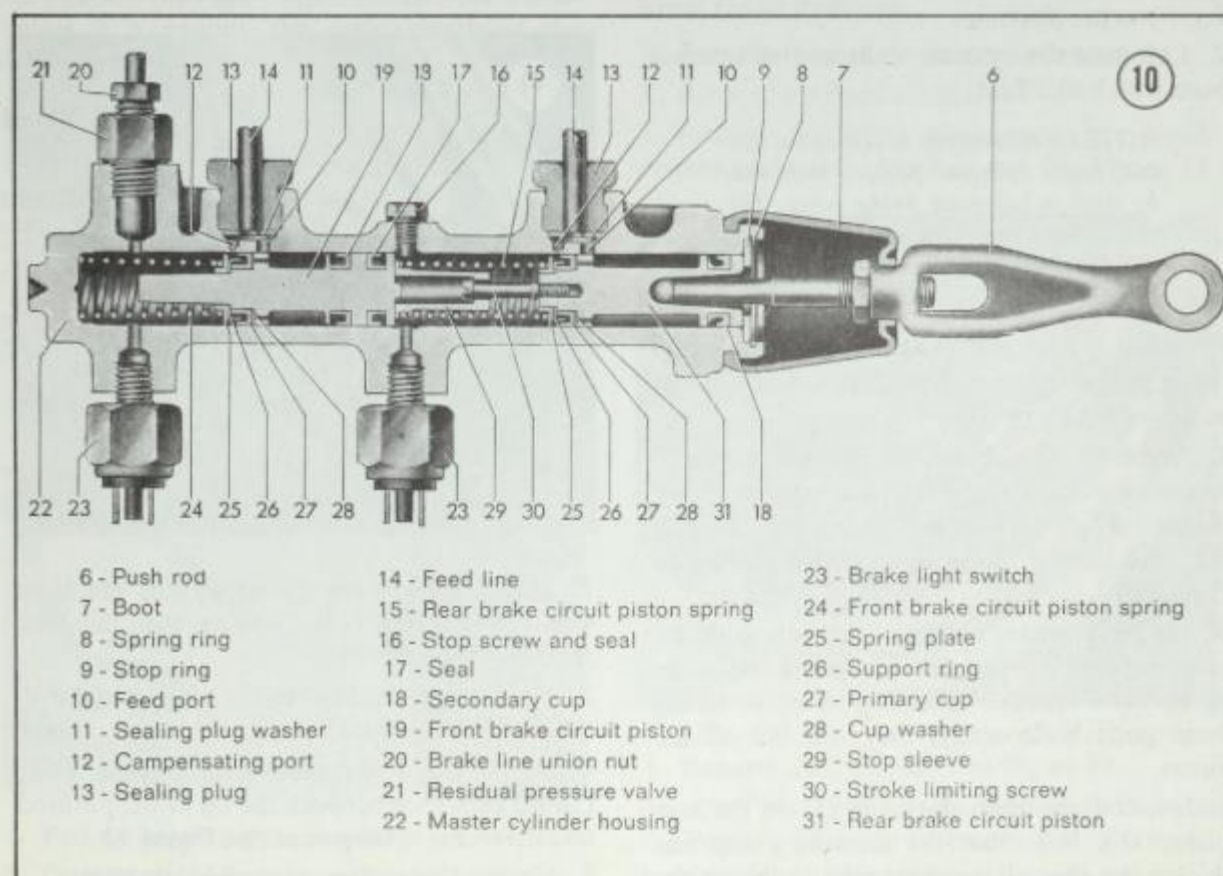
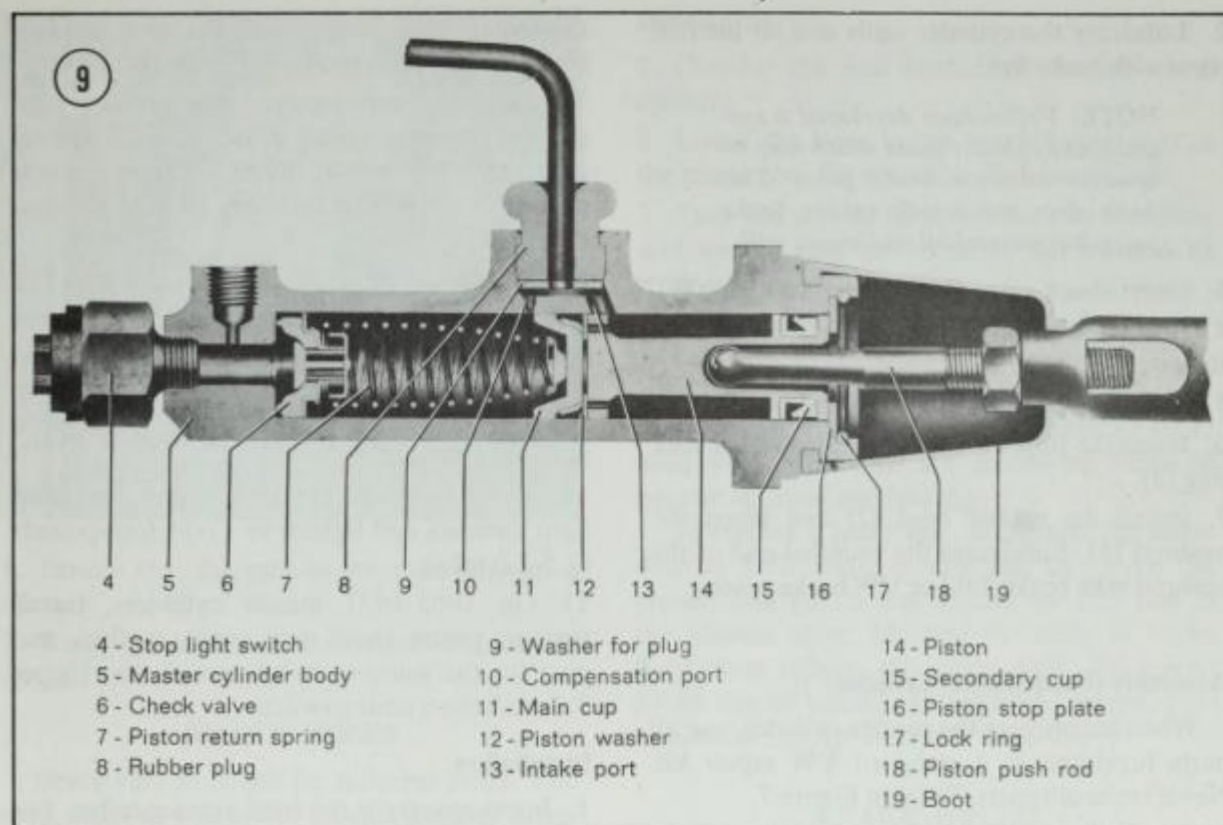
NOTE: Both ATE and Schaefer manufacture brake parts for VW. While complete cylinders can be exchanged, internal parts from one make cannot be used with the other.

Assembly (Single Master Cylinder)

When assembling the master cylinder, use parts from a standard VW repair kit. Never reuse old parts. Refer to Figure 6.

1. Clean all parts in alcohol or brake fluid. Blow dry if you use alcohol.





2. Lubricate the cylinder walls and all internal parts with brake fluid.

NOTE: Volkswagen developed a special brake cylinder paste which may be used to lubricate brake parts. This paste does not attack rubber brake parts, but mineral oil and grease will.

3. Insert check valve (10) and return spring (9).
4. Insert the primary cup (8) in the direction shown.
5. Insert the piston washer (7) and piston (6).
6. Insert the stop washer (4) and install the lock ring (3).
7. Install the rubber boot (2) and insert the pushrod (1). Lubricates the rounded end of the pushrod with brake fluid or VW brake paste.

Assembly (Dual Master Cylinder)

When assembling the master cylinder, use all parts furnished in a standard VW repair kit. Never reuse old parts. Refer to Figure 7.

1. Clean all parts in alcohol or brake fluid. Blow dry if you use alcohol.
2. Lubricate the cylinder walls and all internal parts with brake fluid.

NOTE: Volkswagen developed a special brake cylinder paste which may be used to lubricate brake parts. This paste does not attack rubber brake parts, but mineral oil or grease will.

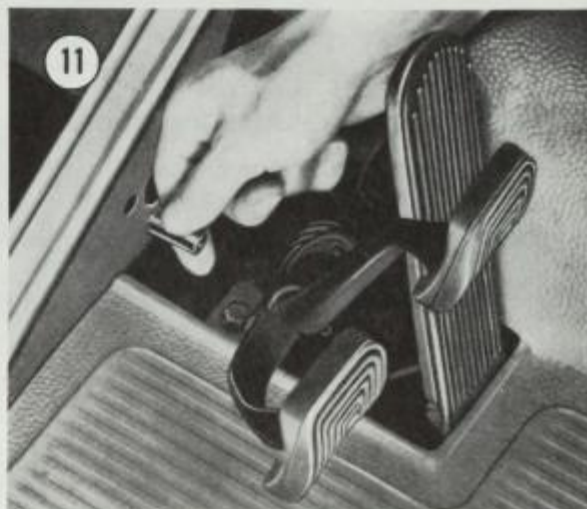
3. Install a new seal (14) and secondary cup (5) on the front piston. Install with the open end as shown in Figure 10.
4. Assemble the cup washer, new primary cup, support washer, spring plate, and tapered spring (items 7-10 & 16) on the front piston. Install the open end of the primary cup as shown in Figure 10.
5. Hold the master cylinder vertically with the open end down. Insert the front piston assembly up into the cylinder bore. If you try to install these parts horizontally, they will fall off the piston.
6. Install a new secondary cup (5) on the rear piston (6). Note that the secondary cup has thicker lips than all the other cups in the master

cylinder. Install the cup with the open end facing in the direction shown in Figure 10.

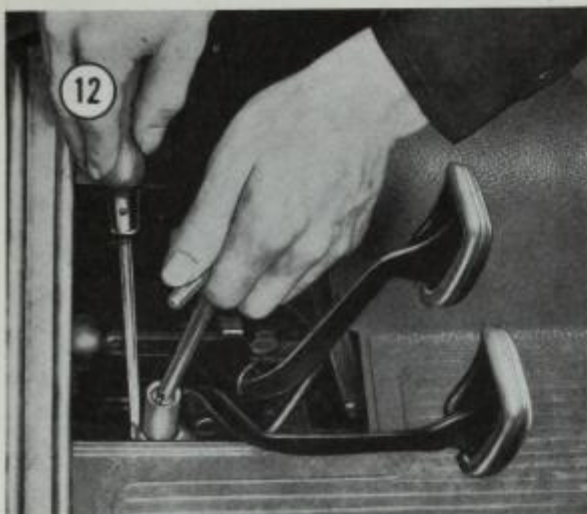
7. Install the cup washer, new primary cup, support washer, spring plate, straight spring, stop sleeve and screw, (items 7-13) on the rear piston (6). Insert the assembly into the cylinder bore.
8. Install the stop washer (4) and lock ring (3).
9. Check that the rear piston is not blocking the stop screw hole, and insert the stop screw and seal (23 & 24). If the hole is blocked, push the rear piston towards the front with the pushrod until the hole is clear.
10. Install residual pressure valves and stop light switches and tighten to 11-14 foot-pounds (1.5-2.0 mkg).
11. On 1968-1971 master cylinders, install springs, piston (with new cups), washer, and plug for the warning switch circuit. See Figure 8. Install the warning switch.

Installation

1. Insert spacers in the front cross member. See Figure 11.



2. Install the master cylinder from the front with 2 mounting bolts. Ensure that the boot remains in place.
3. Connect the pushrod to the brake pedal with the pin. Use a new lock plate.
4. Adjust pedal stop plate until there is 0.04" (1mm) clearance between the tip of the pushrod and the recess in the piston. See Figure 12.
5. Connect brake lines and stop light wire.



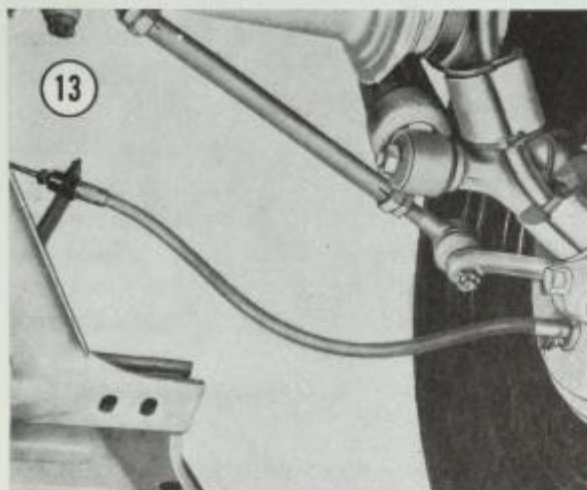
6. Ensure that the vent in the reservoir cap is open.
7. Bleed the brakes as described later in this chapter.

BRAKE HOSES

Hoses vary in length for different years. You must order new hoses by chassis number to ensure getting the right length. Do not use a hose unless it is exactly the same length as the original.

Removal

1. Remove the wheel associated with the defective brake hose.
2. Loosen the union nut and remove the hose clip from the bracket. See **Figure 13**.



3. Pull the hose from the bracket.
4. Disconnect the hose from the wheel cylinder.

Installation

1. Connect the new brake hose to the wheel cylinder.
2. Install the hose in the bracket, and tighten the union nut. Do not allow the hose to twist.
3. Turn the wheels from one lock to the other and ensure that the hose is not twisted or strained.
4. Bleed the brakes.

BRAKE LINES

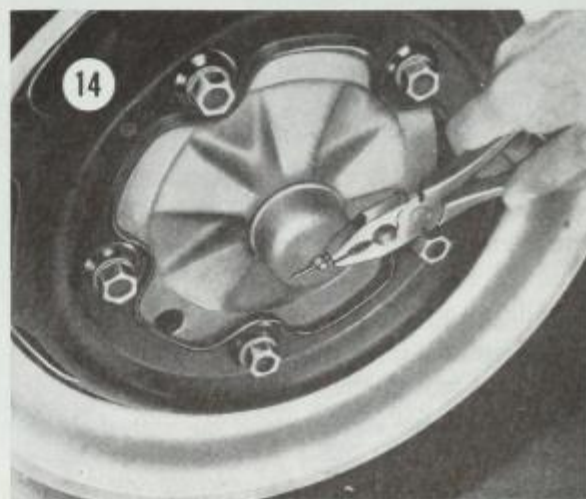
The brake lines are steel with 0.028" (0.72 mm) walls. The ends are double-lap flared to prevent splitting and leaking.

To replace a brake line, disconnect the union nuts at both ends. Unclip the line from the chassis and pull it out. Install the new line in the chassis clips. Moisten the ends in brake fluid, then tighten the union nuts. To ensure brake line of suitable strength and length, purchase new lines from your VW dealer.

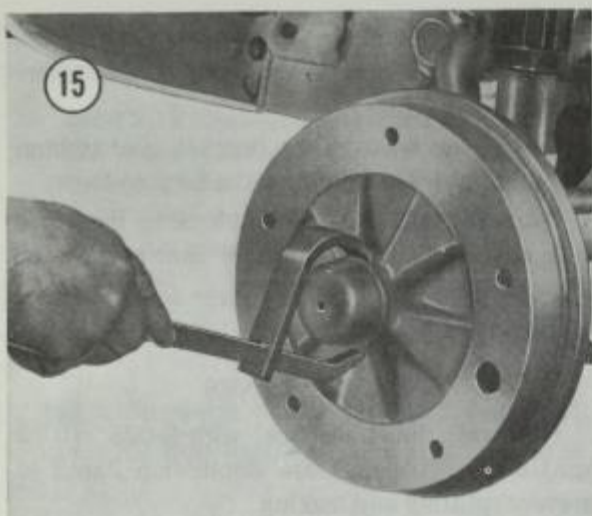
BRAKE DRUMS

Front Drum Removal

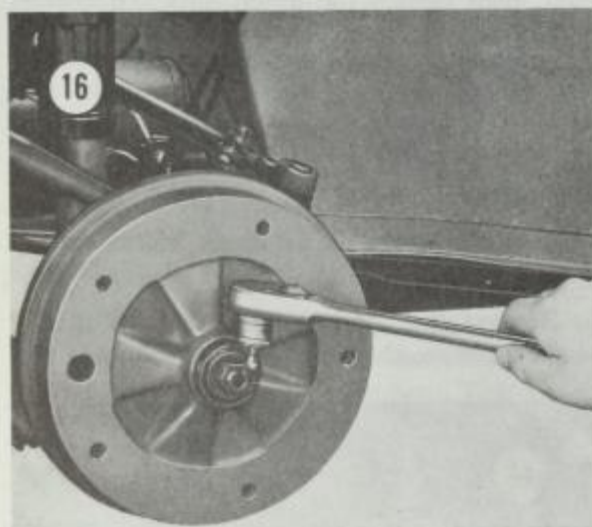
1. Jack the front of the car up on jack stands.
2. Remove the front wheels.
3. Remove the cotter pin securing the speedometer cable to the left dust cap. See **Figure 14**.



4. Remove the dust caps. See **Figure 15**.
 - 5a. On 1961-1965 wheels, bend up the tabs on the locking plate and remove the outer nut, locking plate, and inner nut.



5b. On 1966-1972 wheels, loosen the adjusting nut clamp bolt with a 6mm allen wrench. See **Figure 16**. Screw the nut off; the left nut has a left-hand thread.



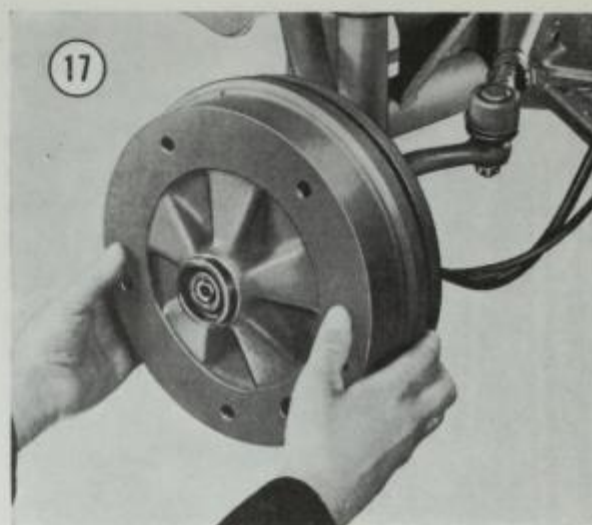
6. Pull the brake drum out as far as it goes, then push it back in (see **Figure 17**). This leaves the thrust washer and outer bearing where they may be easily removed.

7. Pull the brake drum off. If necessary, back off the brake adjustment. See brake adjustment procedures later in this chapter.

8. Lay the drum over a clean rag with the outside up. Insert a piece of wood through the hub opening and pound around the inner bearing in a circle until the bearing and oil seal drop out.

Rear Drum Removal

1. Put the transmission in gear and pull up the hand brake.



2. Loosen the wheel lug bolts.

3. Remove the cotter key in the castellated hub nut and loosen the nut with a 36mm socket and a long breaker bar. The nut is torqued to 217 foot-pounds.

CAUTION: *Never loosen the nut unless all 4 wheels are firmly on the ground. The force required to loosen the nut is sufficient to knock the car off the jackstand.*

4. Raise the rear of the car on jackstands.

5. Remove the hub nut.

6. Pull the wheel with brake drum off after backing off the brake adjustment. Separate the wheel and drum to permit a thorough inspection.

Inspection

1. Blow brake dust and dirt from the brake drum. Remove grease and oil with cleaning solvent. Blow dry.

2. Clean the drum braking surface with alcohol.

3. Inspect brake drums for scoring, cracking, taper, out-of-roundness, heat evidence, etc. Drums which are scored or worn should be turned by a VW dealer, and brake shoes replaced by oversize shoes. Cracked drums cannot be turned; replace them.

4. Remove glaze on serviceable drums with fine emery cloth.

5. Clean the front wheel bearings thoroughly in solvent and blow dry. Check the balls or rollers for scores, wear, and evidence of overheating (blue tint). Check the bearing races on the axle

stub and brake drum also. Do not mix the bearings up if they are good; they must be replaced on the same wheel. If bearings or races are damaged, refer to the wheel bearing replacement procedure in Chapter Twelve.

6. Clean all traces of grease and dirt from the front axle stubs.

Front Drum Installation

1. Pack both wheel bearings with wheel bearing (lithium) grease. Press grease thoroughly into the cage and balls or rollers.

2. Grease the race on the stub axle lightly.

3. Install the inner bearing and oil seal in the brake drum. The seal should be flush with or slightly below the hub.

4. Pack the hub of the brake drum full of wheel bearing grease. Hold your hand over the inner hole to keep grease from coming out.

5. Install the brake drum, and push any grease that tries to come out of the hub back in. Don't force grease out the back, though.

6. Install the outer bearing (packed in step 1) and thrust washer.

7. Install the hub nut finger tight, then adjust wheel bearings exactly as described in Chapter Twelve.

8. Adjust the brakes.

Rear Drum Installation

1. Install the rear brake drum on the axle, and tighten the nut to about 100 foot-pounds.

2. Install the rear wheel and lower the car.

3. With a large torque wrench, or small one with range extender, tighten the hub nut to 217 foot-pounds.

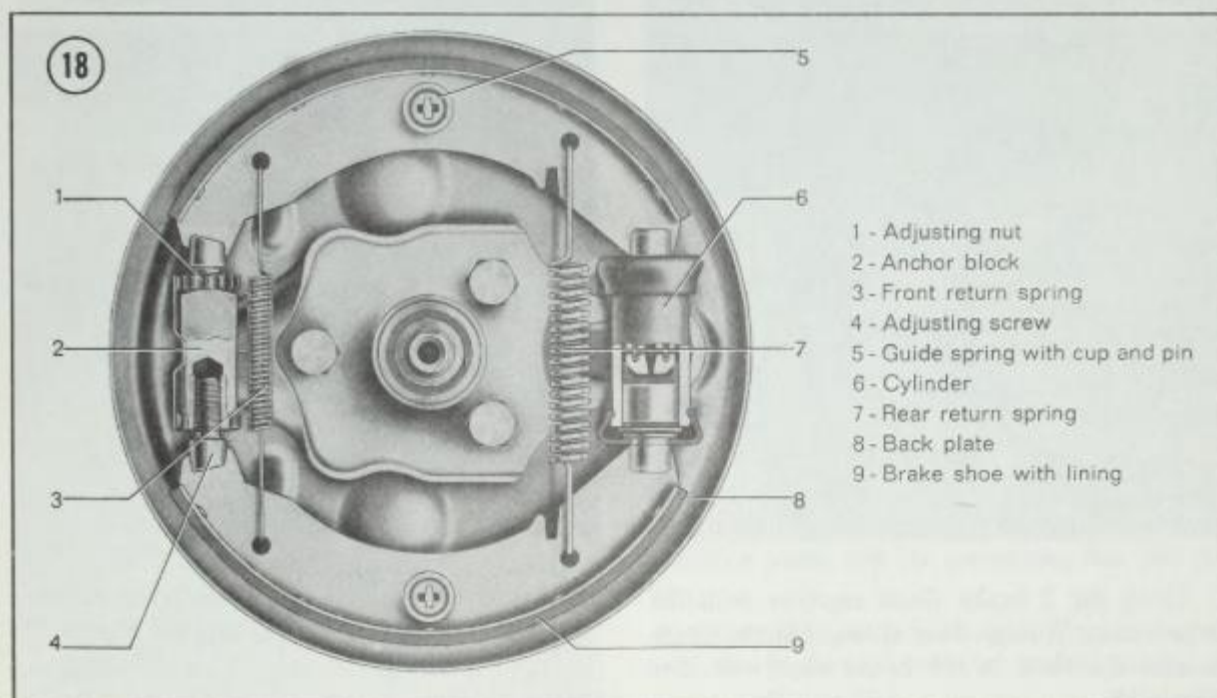
CAUTION: *Never tighten the nut unless all 4 wheels are firmly on the ground. The force required to tighten the nut is sufficient to knock the car off the jackstands.*

4. Install the cotter key through the nut castellations. If the hole in the hub does not line up, tighten the nut additionally until the cotter key fits. Spread the ends of the cotter key.

5. Adjust the brakes.

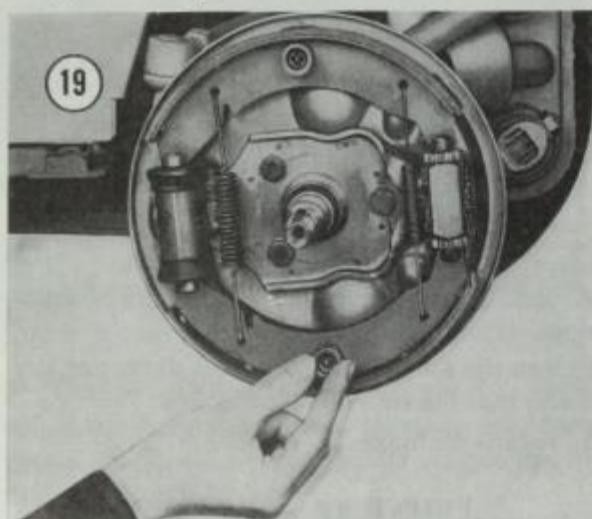
FRONT BRAKE SHOES

Brake shoes require relining or replacement when linings are soaked with oil, grease, or brake fluid. In addition, replace linings worn to less than 1/16"; check by looking through the brake drum inspection-adjustment holes. If brake drums have been turned, use oversize linings. Always replace linings on both front wheels to ensure uniform braking. Refer to **Figure 18** for the following procedures.



Removal

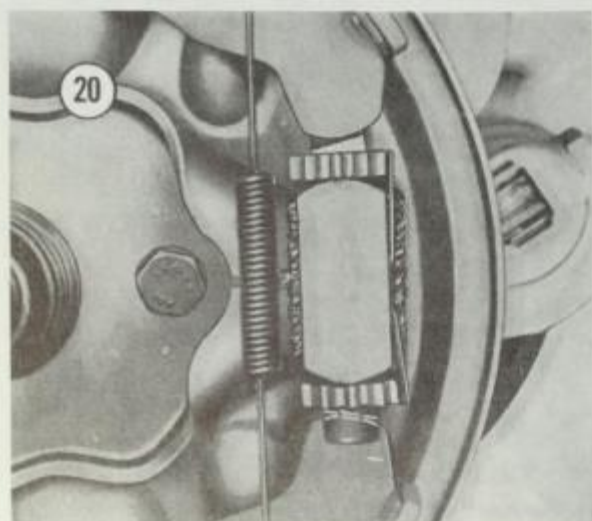
1. Remove the brake drum as described earlier.
2. Remove shoe retainer spring cups, springs, and pins. See **Figure 19**.



3. Disconnect the front (small) return spring.
4. Pull one shoe out of the slot in the adjuster.
5. Lift both shoes out.

Installation

1. Note the bottom of the adjuster slots are angled. Turn the adjusters so the deepest part of the slot is towards the rear of the car. See **Figure 20**.



2. Hook the 2 brake shoes together with the large return spring. This spring fits the holes nearest the slots in the brake shoe web. See **Figure 18**.

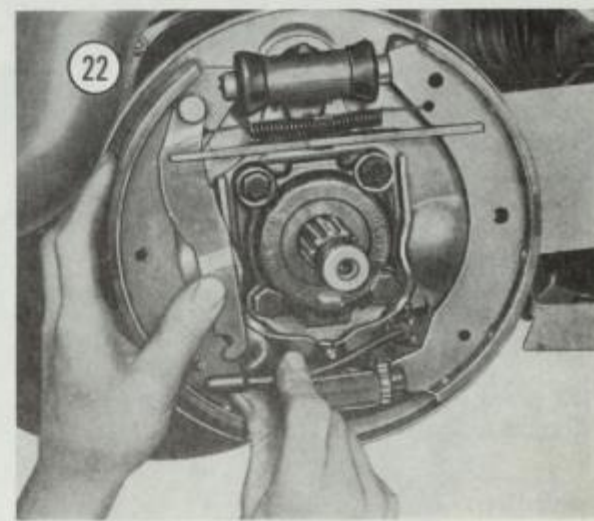
3. Hold the shoes slightly apart to keep the spring in place. Insert the ends nearest the spring into the slots in the wheel cylinder pushrods.
4. Pull the other ends in and fit them in the adjuster slots. Ensure that the angled slots are still in the position shown in **Figure 20**.
5. Install the brake shoe pins, retainer springs, and spring cups.
6. Install the small retainer spring.

REAR BRAKE SHOES

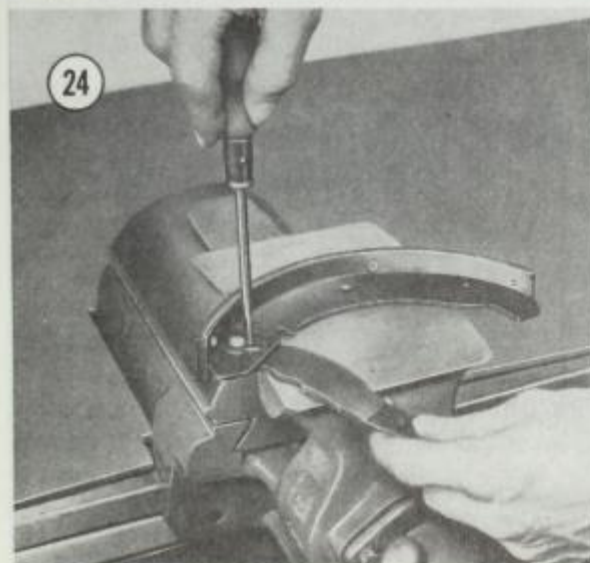
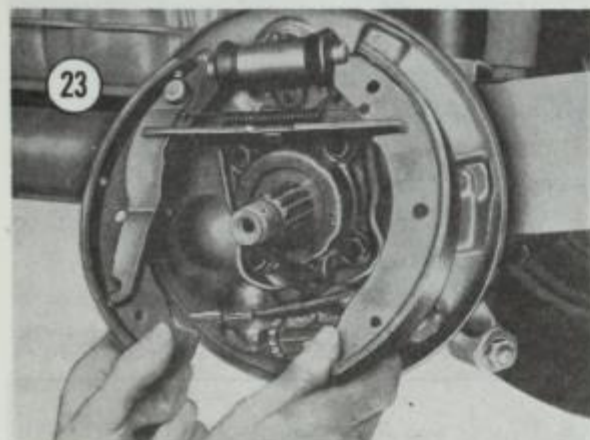
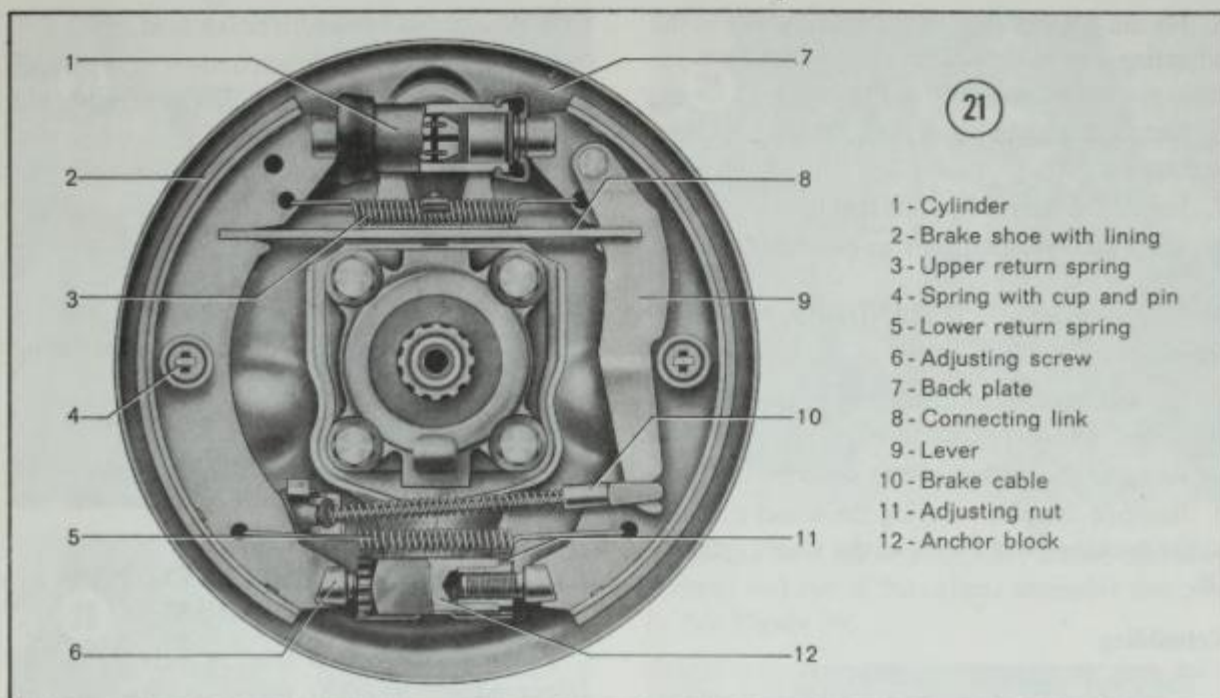
Brake shoes require relining or replacement when linings are soaked with oil, grease or brake fluid. In addition, replace linings worn to less than 1/16"; check by looking through the brake drum inspection-adjustment holes. If brake drums have been turned, use oversize linings. Always replace linings on both rear wheels to ensure uniform braking. Refer to **Figure 21** for the following procedures.

Removal

1. Remove the brake drum as described earlier.
2. Remove the brake shoe retainer spring cups, springs and pins.
3. Unhook the lower return spring, **Figure 21**.
4. Disconnect the brake cable (**Figure 22**).

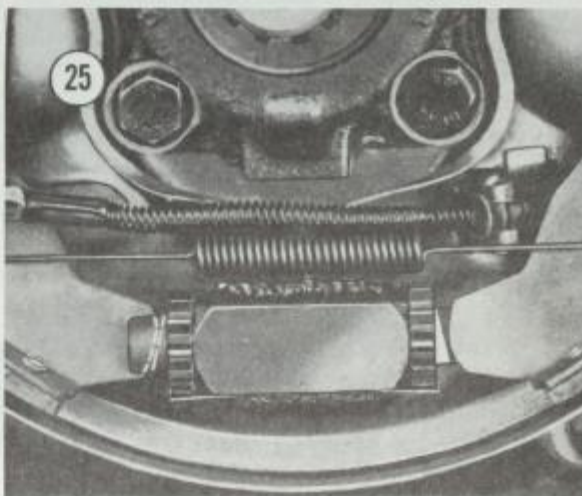


5. Remove the brake shoes with lever connecting link and upper return spring. See **Figure 23**.
6. Remove the C-ring and take the lever off the brake shoes. See **Figure 24**.



Installation

1. Note that the adjusting screw slots are angled. Turn the adjuster until the deepest part of the slot faces up. See **Figure 25**.



2. Install the hand brake lever on the rear brake shoe.
3. Connect the upper return spring between the brake shoes. Use the holes nearest the slots in the shoe webs. Slip the connecting link into the slots.
4. Lift both shoes into position. Engage the top ends in the wheel cylinder pushrod slots as shown in **Figure 23**.

5. Fit the bottom ends of the brake shoes in the adjusting screw slots. Ensure that the slots remain positioned as shown in Figure 25.
6. Install the brake shoe pins, retainer springs, and spring clips.
7. Install the lower retaining spring.
8. Install the brake drums as described earlier.

WHEEL CYLINDERS

Removal

1. Remove the brake drum and brake shoes as described in earlier procedures.
2. Remove the brake hose as described earlier.
3. Remove the bolt securing the wheel cylinder to the backing plate and take the wheel cylinder off.

Rebuilding

Refer to **Figure 26**.

1. Remove both rubber boots.
2. Remove pistons, cups, cup expanders, and spring.
3. Remove bleeder valve.
4. Clean all parts in alcohol or brake fluid.
5. Examine the cylinder bore for scoring, pitting or heavy corrosion. Very light scratches may be removed with **crocus cloth**. Flush out with alcohol and blow dry. Replace wheel cylinders which show more extensive damage.

6. Lubricate all parts with brake fluid.
7. Install new cups, cup expanders, and springs provided in the repair kit. Do not reuse old parts.
8. Install pistons and new rubber boots.
9. Install bleeder valve.

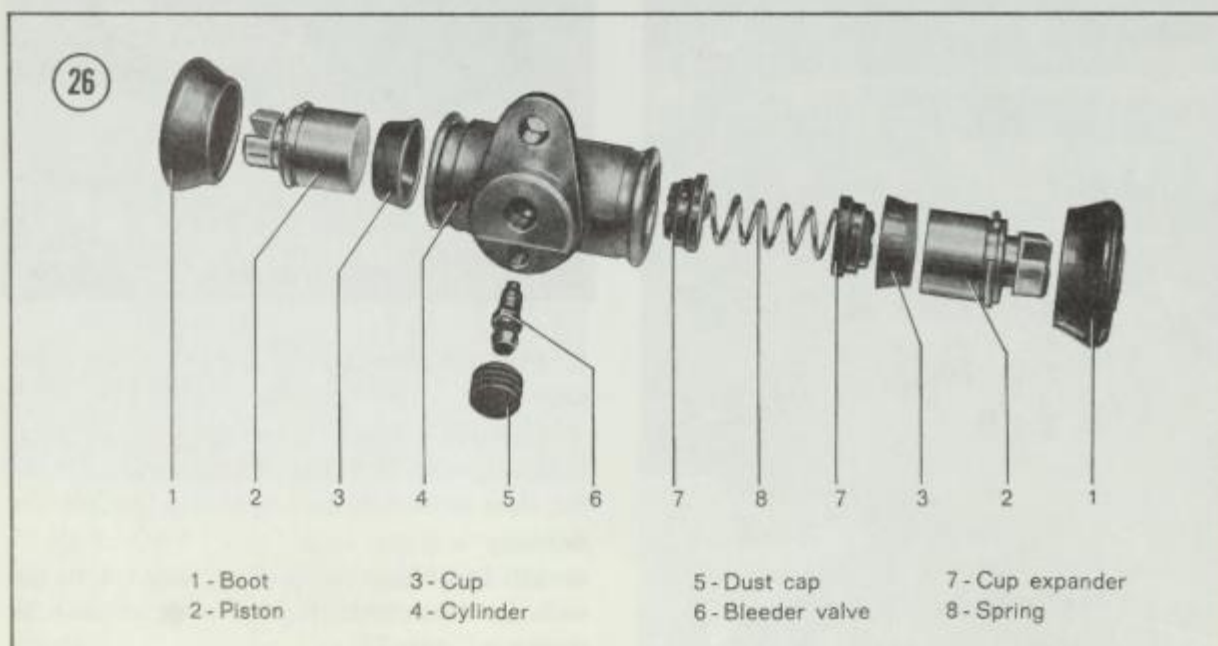
Installation

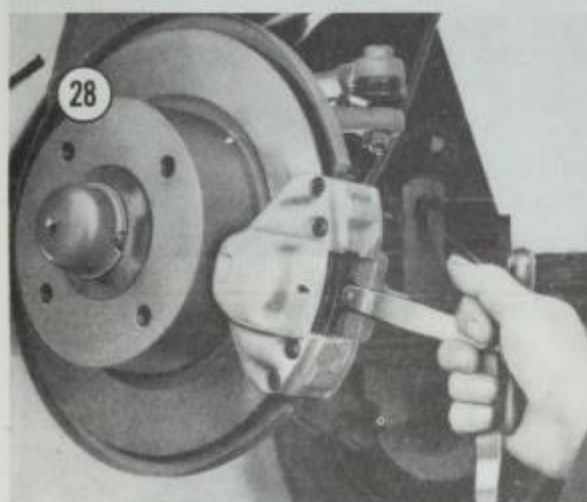
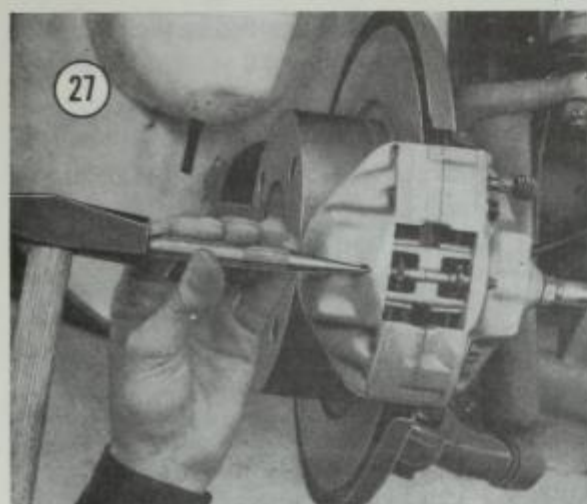
1. Install the wheel cylinder with the mounting bolt.
2. Install the brake hose as described earlier.
3. Install brake shoes as described earlier.
4. Bleed the brakes.

BRAKE PAD REPLACEMENT (KARMANN GHIA)

Brake pads on both front wheels should be inspected every 6000 miles as described in Chapter Two. Replace brake pads on both front wheels if pad thickness is 0.08" (2mm) or less. It is rarely necessary to bleed the brake system after a single brake pad replacement.

1. Jack up the car on jackstands and remove the wheels.
2. With a punch, drive out retaining pin as shown in **Figure 27**.
3. Remove brake pad spreader spring.
4. Pull brake pads out as shown in **Figure 28**.





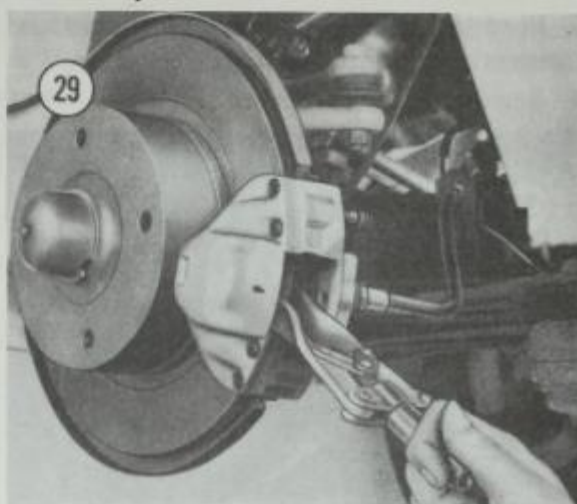
A piece of wire with a hook at one end makes a suitable tool.

CAUTION: If brake pads are to be reinstalled, mark them so they are installed in the same position.

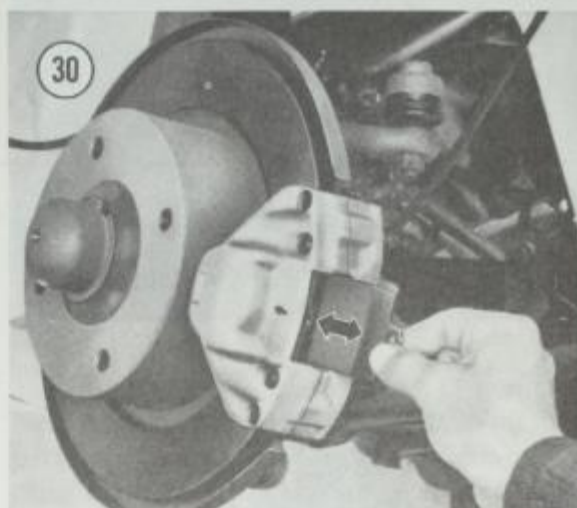
5. Carefully clean out the cavity which holds the brake pads. Inspect the rubber dust covers; if they are damaged, replace them. If dirt has penetrated the cylinders due to a damaged cover, recondition the brake unit as described later.

6. Before installing new brake pads, push the pistons in as shown in **Figure 29**. Open the bleed valve to make this easier. The master cylinder may overflow when the pistons are pressed in. Draw some fluid out first to prevent this, and discard the fluid. Also place rags under the master cylinder to protect the paint.

CAUTION: Do not let brake fluid spill on the brake pads or discs.



7. Install new brake pads, and ensure that they slide in and out of the caliper assembly smoothly. See **Figure 30**.



8. Install a **new** brake spreader spring.

9. Insert the pad retaining pin into the brake caliper. Drive the pin in with a hammer only, not a punch, so that the pin is not inadvertently driven too far.

10. Depress the brake pedal several times before driving the car so the pads can assume correct alignment with respect to the brake disc.

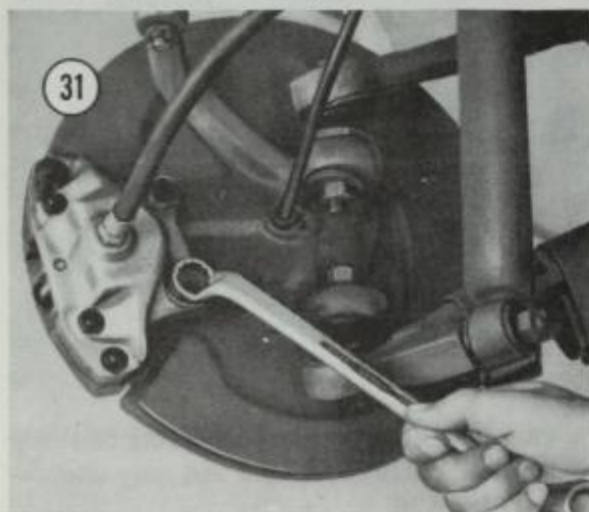
BRAKE CALIPERS

Removal

1. Jack up front of car on jackstands. Remove front wheel(s).

2. Remove brake hose and cover the end to prevent entry of dirt and moisture.

3. Bend lock plates up on mounting bolts and remove the bolts. See **Figure 31**.
4. Remove the brake caliper.

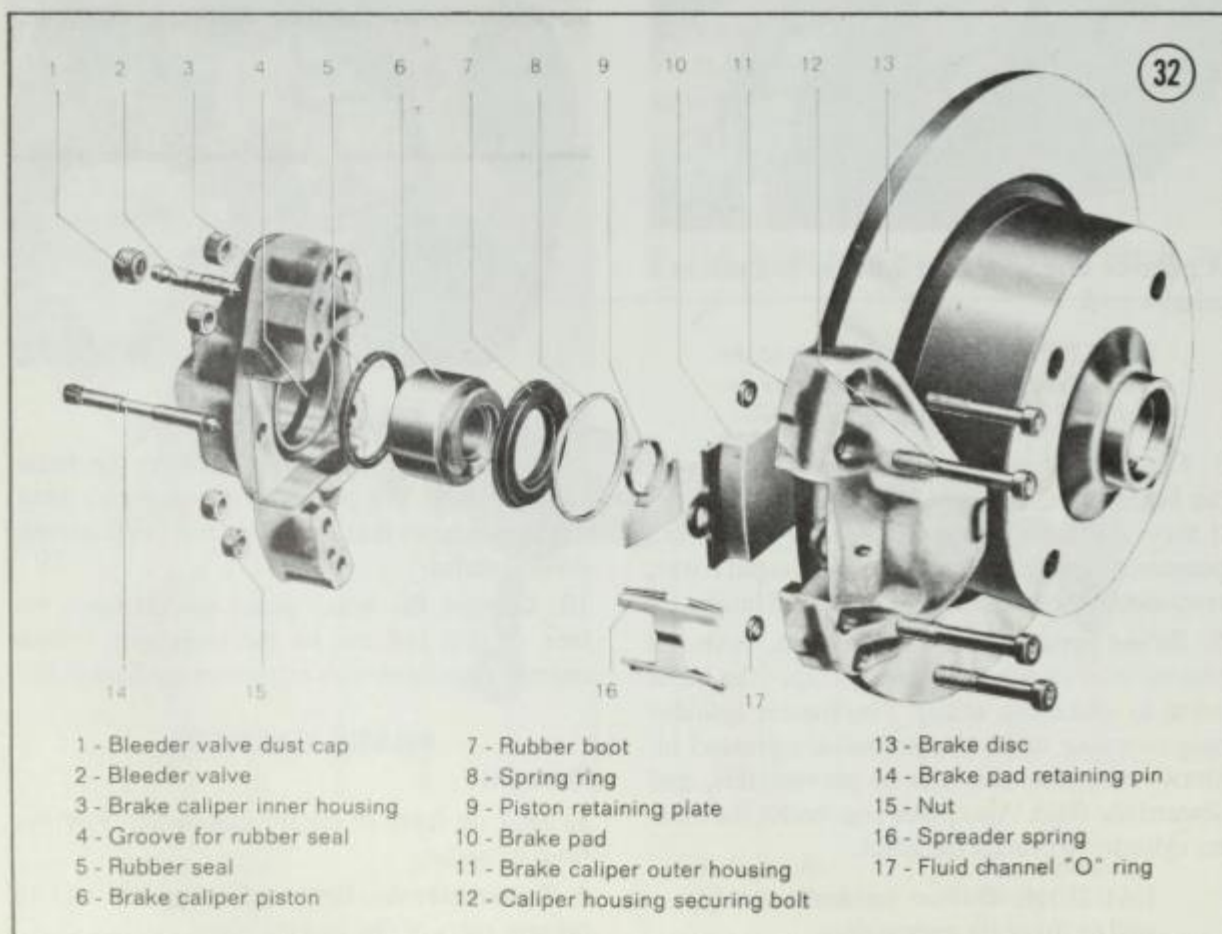
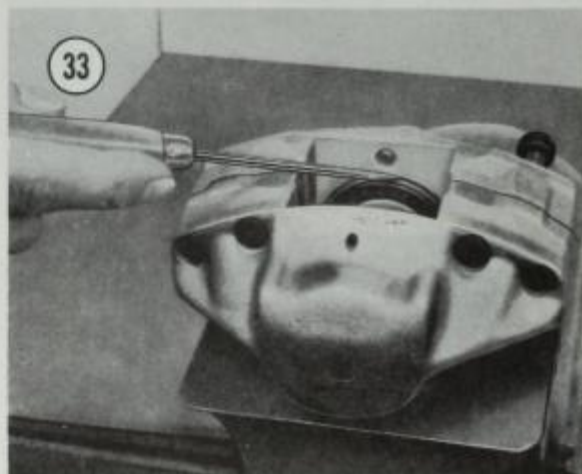


Reconditioning

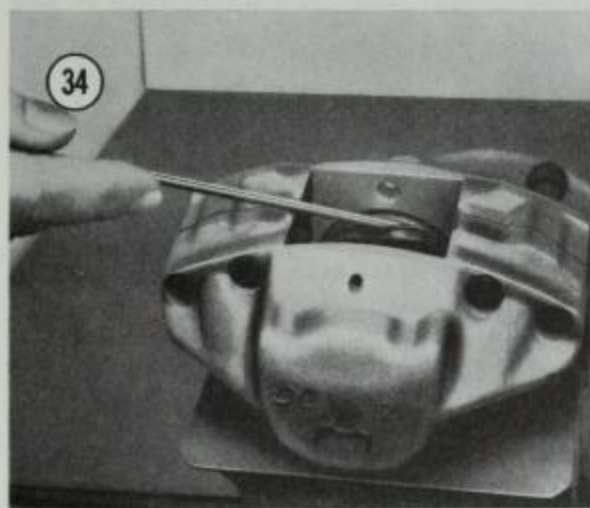
The following procedure describes replacement of all parts included in the VW caliper re-

pair kit. Use all parts included in the kit. Refer to **Figure 32** for an exploded view of the caliper assembly.

1. Remove brake pads as described earlier.
2. Clamp the caliper in a vise and remove piston retaining plates.
3. Pry out the rubber boot retaining ring as shown in **Figure 33**. Do not damage rubber boot.

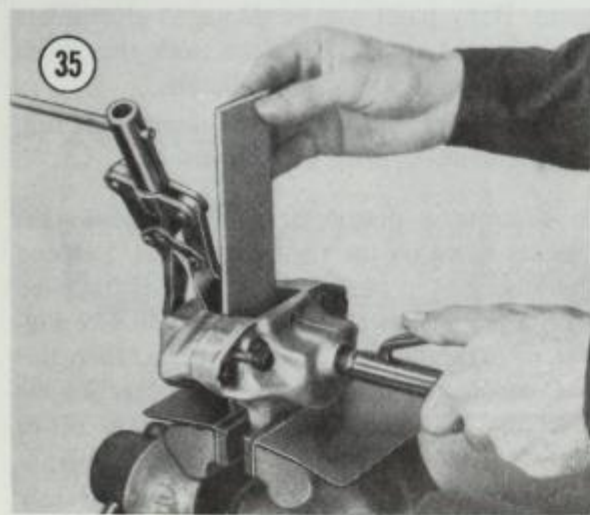


4. Remove rubber boot, using a plastic or rubber rod. See **Figure 34**.



5. Clamp one piston in place as shown in **Figure 35**. Hold a piece of $\frac{1}{4}$ " thick wood in the housing and force the other piston against it with compressed air.

NOTE: Once one piston is removed, pressure cannot be built up to force the other out. Therefore, completely rebuild one side before working on the other.

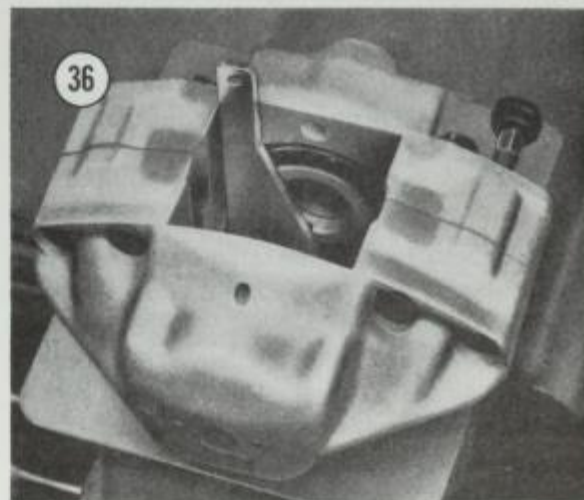


6. Remove the rubber seal with a plastic or rubber rod to prevent damage to housing.
 7. Clean all parts in alcohol or clean brake fluid.
 8. Check parts for wear. If a cylinder is worn or damaged, the complete caliper must be replaced.

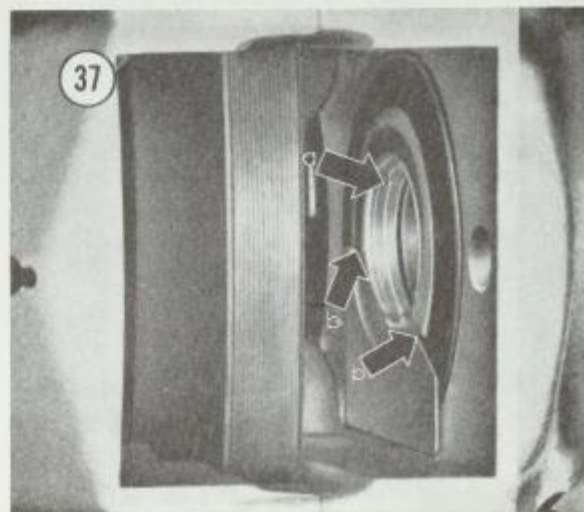
9. Coat the rubber seal and piston with special VW brake cylinder paste. Install the seal and piston.

CAUTION: VW uses a special installation tool to ensure that the piston does not tilt when pressed in. Consider taking the caliper to VW for this operation.

10. Install new rubber boot and retaining ring.
 11. Insert the special gauge shown in **Figure 36** to ensure that the piston recess is inclined 20° from the lower guide area of the caliper.



12. Install piston retaining plate (**Figure 37**). Note that the circular part of the plate (a) must be firmly pressed into the piston crown. The plate must lie below the recessed part of the piston (b).



13. Repeat steps 5-12 for the other piston/cylinder.

14. Do not disassemble the caliper assembly any further. If the caliper assembly leaks, take it to a VW dealer for repair.

BRAKE DISC

Inspection

Check the brake disc for deep scratches, excessive run-out, and uneven thickness.

Small marks on the disc are not important, but deep radial scratches reduce braking effectiveness and increase pad wear.

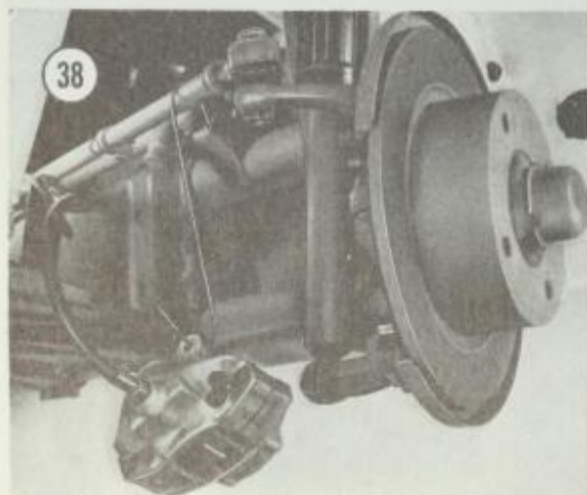
To check disc run-out, use a dial indicator and rotate the disc; run-out should not exceed 0.008" (0.2mm). This procedure assumes that the wheel bearings are properly adjusted. Check them if in doubt.

Check the thickness of the disc with a micrometer. Make about 12 measurements around the disc about 1" from the outer edge. Measurements should not vary more than 0.0008" (0.02mm).

If the disc has excessively deep scratches, excessive run-out, or variation in thickness, renew or replace the disc. If the disc is renewed, minimum thickness must be at least 0.335" (8.5mm), and an equal amount must be removed from each side.

Replacement

1. Remove caliper as described earlier, except leave brake hose attached and brake pads installed. Hang the assembly up with a piece of wire. See **Figure 38**.



2. Remove dust cap over bearing clamp nut. The C-ring must be removed from the left dust cover before it can be removed.

3. Loosen the clamp nut allen screw and unscrew the nut.

4. Pull the disc out about 1" and push it back in. This leaves the thrust washer and outer bearing where they may be easily removed.

5. Pull the brake disc off.

6. Install the brake disc, bearing, thrust washer and clamp nut. Tighten the nut finger tight, then adjust wheel bearings exactly as described in Chapter Twelve.

7. Install caliper and wheel.

BRAKE BLEEDING

Brakes require bleeding whenever air enters the system, lowering the effective braking pressure. Air can enter when the master cylinder or wheel cylinders are serviced, or if the fluid in the reservoir runs dry. Air can also enter through a leaky brake line or hose. Find the leaky line and replace it before bleeding.

Whenever handling brake fluid, do not get any on the brake shoes or body paint. Brake shoes will be permanently damaged, requiring replacement. Body paint can be damaged also unless you wipe the area with a clean cloth, then wash it with a soapy solution immediately.

1. Ensure that the brake fluid reservoir is full, and that the vent in the cap is open.

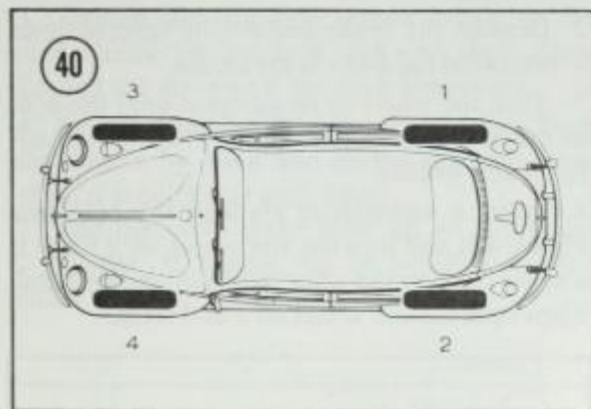
2. Connect a plastic or rubber tube to the bleeder valve on the right rear wheel. Suspend the other end of the tube in a jar or bottle filled with a few inches of clean brake fluid. See **Figure 39**. During the remaining steps, keep this end submerged at all times and never let the level in the brake fluid reservoir drop below about 1/2 full.

3. Open the bleeder valve on the right rear wheel about 1 turn. Have an assistant depress the brake pedal slowly to the floor. As soon as the pedal is all the way down, close the bleeder valve and let the pedal up. Repeat this step as many times as necessary, i.e., until fluid with no air bubbles issues from the tube.

4. Bleed the remaining valves in the same manner described in the steps above. Follow the



sequence shown in **Figure 40**. Keep checking the brake fluid reservoir to be sure it doesn't run out of fluid.



5. When all wheels are bled, discard the brake fluid in the jar or bottle; never reuse such fluid. Top up the brake fluid reservoir with clean brake fluid.

HAND BRAKE

Cable Replacement

1. Remove the lock and adjusting nuts from the threaded cable ends at the hand brake lever.

These nuts are accessible through slots in the lever cover. See **Figure 44**.

2. Raise the rear of the car on jackstands and remove the rear wheels.

3. Remove the rear brake drums and brake shoes as described in earlier procedures.

4. Detach the cable clip from the backing plate at each wheel.

5. Pull the cable ends with guide tubes out of the backing plate.

6. Pull the cable out of the guide tubes from the front.

7. Compare the length of new cables to old cables. Cables used from 1961-1965 are shorter than in later years.

8. Grease the cables with universal grease and push them into the guide tubes from the front.

9. Reconnect the guide tubes to the backing plate.

10. Install the brake shoes and brake drums as described in earlier procedures.

11. Connect the front cable ends to the hand brake lever using the adjusting nuts and lock nuts.

12. Adjust the rear foot brakes, then the hand brake as described in a later procedure.

Lever Removal

Refer to **Figure 41** for the following procedure.

1. Remove the front seats and front floor covering.

2. Pull the brake lever cover off.

3. Remove the nuts on the cable ends and lift off the compensating lever.

4. Remove the lock ring securing the lever pin and pull the pin out. See **Figure 42**.

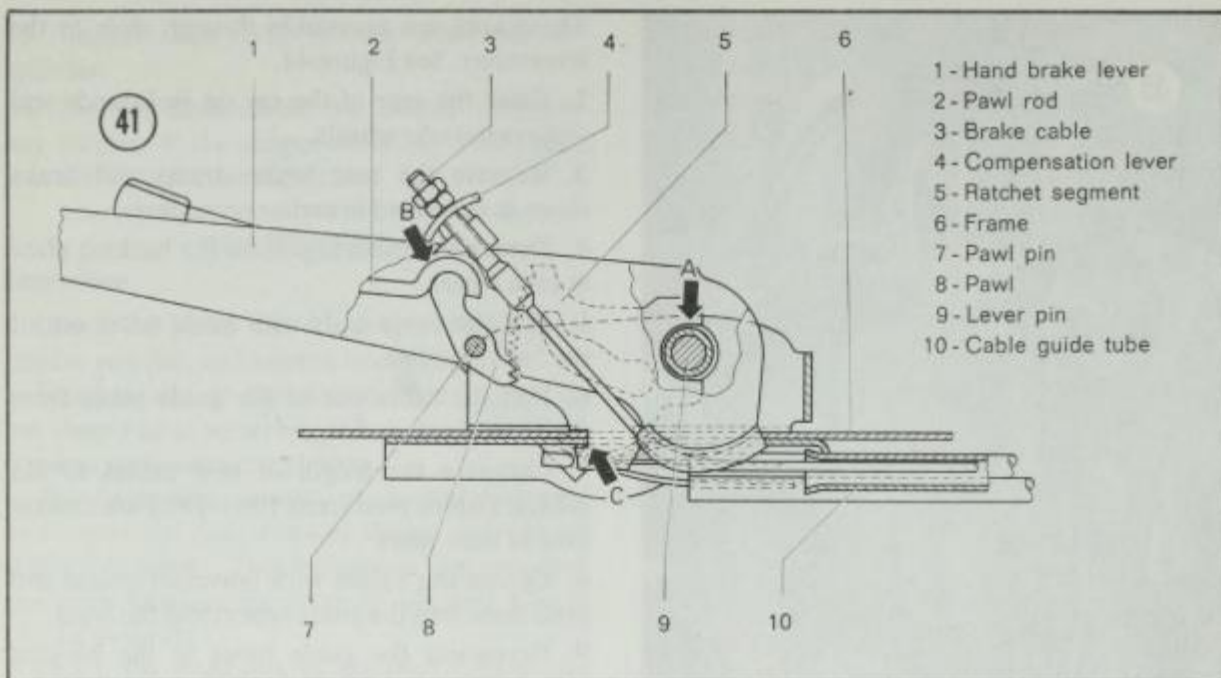
5. Without pressing the release button, push the lever rearward and lift it out complete with ratchet segment.

6. Press the release button and take the ratchet segment out.

Lever Inspection & Cleaning

1. Disassemble the lever and clean the pawl rod, release button, pawl spring, and ratchet segment in solvent.

2. Grease all parts and reassemble.



Lever Installation

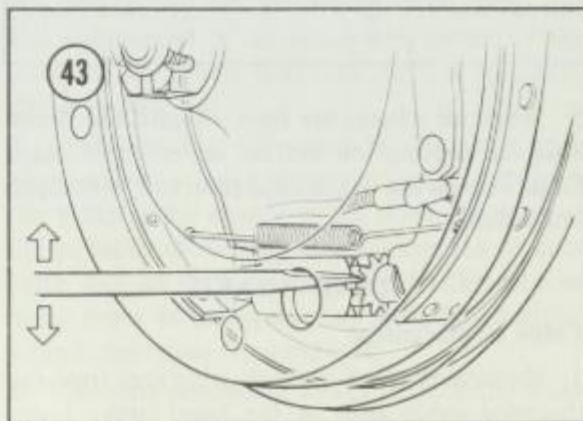
1. Insert the ratchet segment so the half round hole in the segment fits over the lever pin tube, and the teeth engage in the pawl. See Figure 41.
2. Insert the lever without pressing the release button. Guide the threaded ends of the cable into the side holes provided.
3. Grease the lever pin and insert it. Install the lock ring.
4. Install the compensating lever.
5. Connect the cables with the adjusting and lock nuts.
6. Install the lever cover.
7. Replace the floor covering and install the front seats.

8. Adjust the hand brake as described later and road test.

BRAKE ADJUSTMENT

Foot Brake

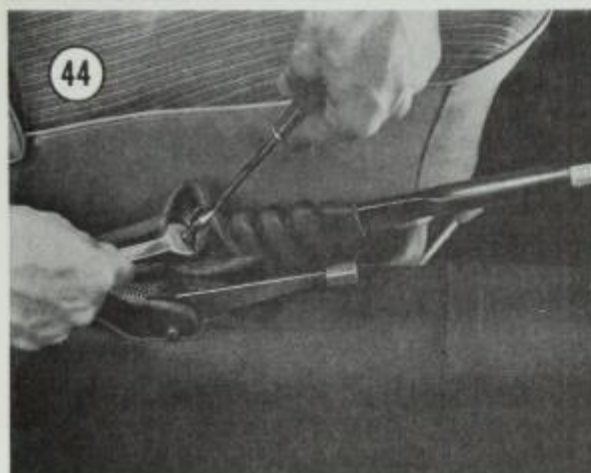
1. Raise the car on jackstands and release the hand brake.
2. Depress the brake pedal fully several times to centralize the shoes in the drums.
3. Turn the wheel to be adjusted until the hole in the brake drum lines up with one of the adjuster star wheels.
4. Insert a screwdriver through the hole (see Figure 43) and turn the star wheel until there is a slight drag on the wheel when turned by hand. Then back the star wheel off 3 or 4 teeth.



- Repeat steps 3 and 4 for the other star wheel on this brake.
- Repeat steps 3-5 on the other 3 wheels.
- Road test the car. Check pedal free play and ensure that the car does not swerve to one side. If it does, recheck the adjustments.

Hand Brake

- Raise the rear of the car on jackstands, and release the hand brake.
- Loosen the lock nuts on the adjusting screws which are accessible through slots in the lever boot (see Figure 44).



- Tighten the adjusting screws evenly so the rear wheels turn by hand with only slight drag. Loosen the screws till the drag disappears.
- Pull the hand brake lever up 2 notches. Turn the wheels by hand and ensure that the same effort is required for each wheel.
- Pull the hand brake lever up an additional 2 notches. It should not be possible to turn either wheel by hand.

- Tighten the locknuts and slip them back in the boot.
- Road test the car to ensure that the brakes hold the car properly.

Table 2 SPECIFICATIONS, DISC BRAKES

Brake Disc	
Diameter	10.9" (277mm)
Thickness (new)	0.374-0.004" (9.5-0.1mm)
Min. thickness	0.335" (8.5mm)
Thickness variation	0.0008" (0.02mm)
Lateral run-out (max.)	0.008" (0.2mm)
Brake Caliper	
Piston diameter	1.5748" (40mm)
Brake Pads	
Thickness (new)	0.394" (10mm)
Min. thickness	0.08" (2mm)
Area (4 pads)	12.2 in. ² (72cm ²)

Table 3 TIGHTENING TORQUES

	foot-pounds	mkg
Master cylinder		
Mounting bolts	18	2.5
Stop screw	3.6-7.0	0.5-1.0
Residual pressure valve	14	2.0
Brake lines	11-15	1.5-2.0
Front brakes		
Backing plate bolts	36	5.0
Wheel cylinder mounting bolt	18	2.5
Bleeder valve	3.6	0.5
Brake hose	11-15	1.5-2.0
Rear brakes		
Wheel cylinder mounting bolts	14-22	2.0-3.0
Brake drum nut	253	35
Bearing cover bolts	4.4	6.0
Pedal Cluster		
Mounting bolt	29-33	4.0-4.5
Stop plate bolt	14-18	2.0-2.5

Table 1 SPECIFICATIONS

		1961-1967	1968-1972 (except Super Beetle)	1971-1972 Super Beetle
SINGLE MASTER CYLINDER				
Bore	inch (mm)	0.687 (17.46)	— — —	— — —
Stroke	inch (mm)	1.299 (33)	— — —	— — —
DUAL MASTER CYLINDER				
Bore	inch (mm)	— — —	0.750 (19.05)	0.750 (19.05)
Front circuit stroke	inch (mm)	— — —	0.556 (15.5)	0.689 (17.5)
Rear circuit stroke	inch (mm)	— — —	0.493 (12.5)	0.453 (11.5)

(continued)

Table 1 SPECIFICATIONS (Continued)

	1961-1967	1968-1972 (except Super Beetle) *	1971-1972 Super Beetle
FRONT BRAKE DRUMS			
Diameter (new) inch (mm)	9.059 + 0.008 (230.1 + 0.2)	9.059 + 0.008 (230.1 + 0.2)	9.768 + 0.008 (248.1 + 0.2)
Max. diameter (turned) inch (mm)	9.102 + 0.008 (231.2 + 0.2)	9.102 + 0.008 (231.2 + 0.2)	9.811 + 0.008 (249.2 + 0.2)
Taper inch (mm)	0.004 (0.1)	0.004 (0.1)	0.004 (0.1)
Out-of-roundness inch (mm)	0.004 (0.1)	0.004 (0.1)	0.004 (0.1)
REAR BRAKE DRUMS			
Diameter (new) inch (mm)	9.055 + 0.008 (230 + 0.2)	9.055 + 0.008 (230 + 0.2)	9.055 + 0.008 (230 + 0.2)
Max. diameter (turned) inch (mm)	9.098 + 0.008 (230.1 + 0.2)	9.098 + 0.008 (230.1 + 0.2)	9.098 + 0.008 (230.1 + 0.2)
Taper inch (mm)	0.004 (0.1)	0.004 (0.1)	0.004 (0.1)
Out-of-roundness inch (mm)	0.004 (0.1)	0.004 (0.1)	0.004 (0.1)
WHEEL CYLINDER DIAMETER			
Front inch (mm)	0.875 (22.2)	0.875 (22.2)	1.13 (23.81)
Rear inch (mm)	0.750 (19.05)	0.687 (17.46)	0.687 (17.46)
FRONT LININGS			
Width inch (mm)	1.57 (40)	1.57 (40)	1.57 (40)
Area (2 wheels) inch ² (cm ²)	55.5 (358)	55.5 (358)	55.5 (358)
Thickness (new) inch (mm)	0.15-0.16 (3.8-4.0)	0.15-0.16 (3.8-4.0)	0.15-0.16 (3.8-4.0)
Oversize available	0.17-0.18 (4.3-4.5)	0.17-0.18 (4.3-4.5)	0.17-0.18 (4.3-4.5)
REAR LININGS			
Width inch (mm)	1.18 (30)	1.57 (40)	1.77 (45)
Area (2 wheels) inch ² (cm ²)	40.5 (262)	55.5 (358)	69.75 (450)
Thickness (new)	0.15-0.16 (3.8-4.0)	0.15-0.16 (3.8-4.0)	0.15-0.16 (3.8-4.0)
Oversize available	0.17-0.18 (4.3-4.5)	0.17-0.18 (4.3-4.5)	0.17-0.18 (4.3-4.5)
PEDAL FREE PLAY inch (mm)	0.2-0.28 (5-7)	0.2-0.28 (5-7)	0.2-0.28 (5-7)

CHAPTER THIRTEEN

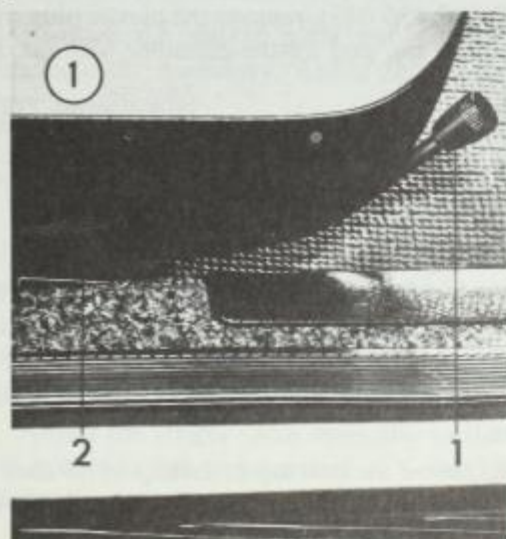
BODY

This chapter includes replacement or repair procedures for the seats, doors, hoods, fenders, and bumpers. In addition, a procedure for door window replacement is included. Other body repairs require special knowledge and/or tools and should be done by your dealer or local body repair shop.

SEATS

Front Seat Removal

1. Lift adjustment lever, and move seat forward until the rear edge contacts the leaf spring. See **Figure 1**.

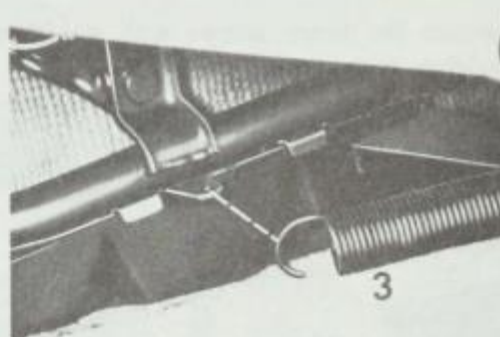


2. Depress the leaf spring with a screwdriver, lift the adjustment lever and slide the seat forward about 1½".

3. Disconnect the tension spring as shown in **Figure 2**.

4. Slide the seat forward and remove it.

2



Front Seat Installation

1. Position the seat in front of the runners.
2. Lift the seat slightly and guide it onto the runner on the tunnel side.

3. Pull the seat slightly towards the door, and guide it into the runner on the door side.
4. Lift the adjustment lever and slide the seat back.
5. Connect the tension spring.

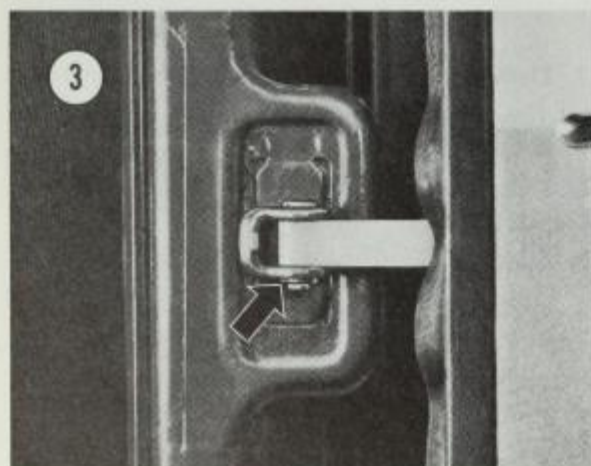
Rear Seat Removal/Installation

1. Raise the front edge of the bottom cushion and pull the seat forward.
2. Tilt one side up and remove the cushion.
3. Installation is the reverse. Ensure that the seat belts are not stuffed behind the cushion. In addition, make sure that they are not twisted.

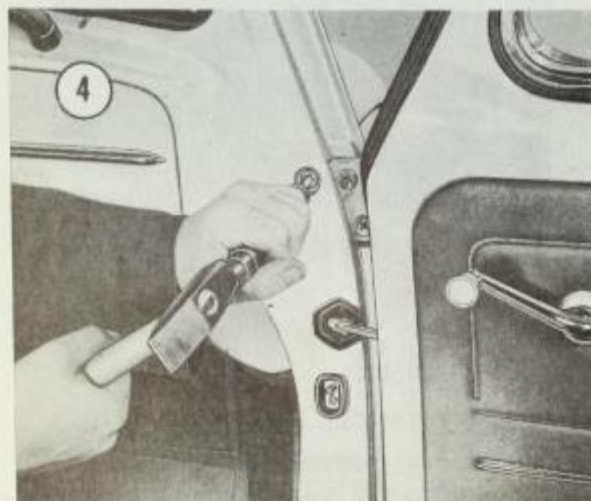
DOORS

Removal

1. Open the door and remove the door stop pin. See **Figure 3**.



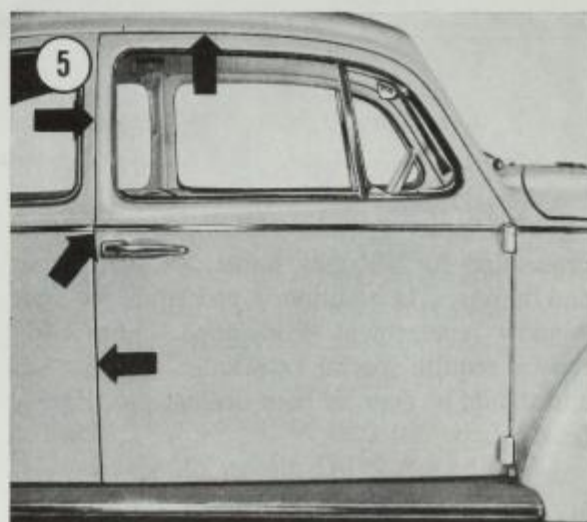
2. Loosen the hinge screws with an impact screwdriver as shown in **Figure 4**.



3. With a helper supporting the door, remove the hinge screws. Pull the door sideways out of the door pillar with hinges attached.

Installation

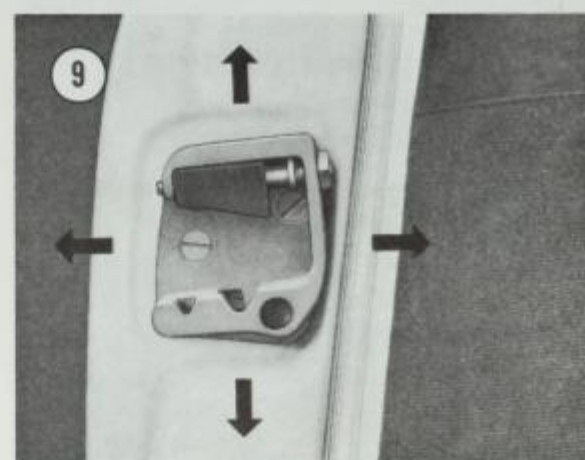
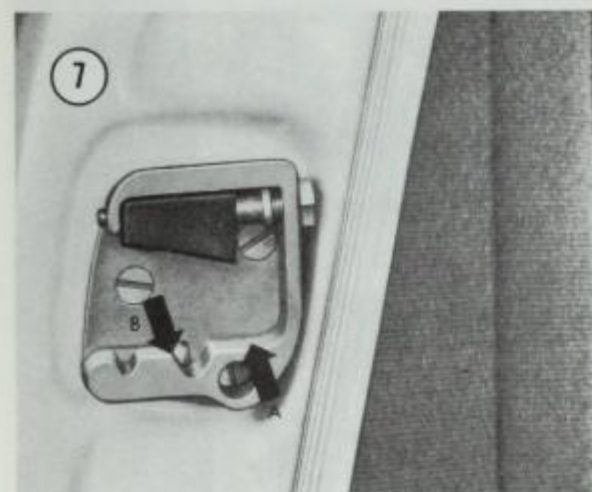
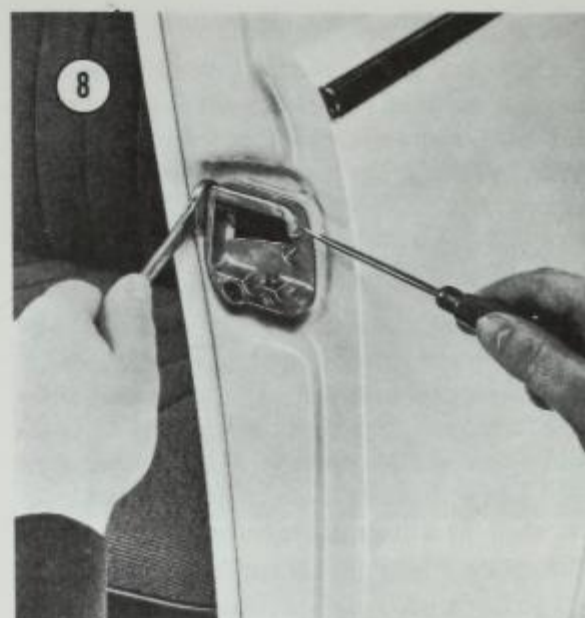
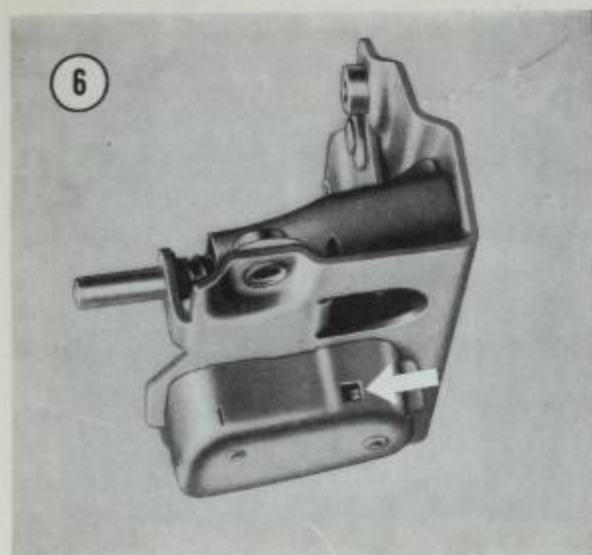
1. Check the door weather-stripping. Replace if damaged.
2. Remove the door striker plate.
3. Install the door and secure the hinges to the door post.
4. Ensure that the door can open and close without jamming and check alignment at the points shown in **Figure 5**. Loosen the door hinge screws and align the door if necessary.



5. Install the strike plate and adjust as described later in this section.
6. Oil the hinge pins. From late 1967 on (chassis # 117 496 043), remove the plastic plug over the hinge pin and fill the chamber with oil. Install the plug.
7. Lubricate the contact surfaces of the striker plate and door wedge lightly with vaseline or molybdenum disulphide paste.

Striker Plate Inspection (1961-1966)

1. Push the door handle button and watch the latch bolt under the latch housing. The latch bolt should retract fully. See **Figure 6**. If it doesn't, the door may be difficult to open and close.
2. Examine the bearing surfaces and notches in the striker plate. See **Figure 7**. If badly worn, replace the striker plate.



3. Examine the plastic wedge for wear and scoring. Replace if damaged.

Striker Plate Adjustment (1961-1966)

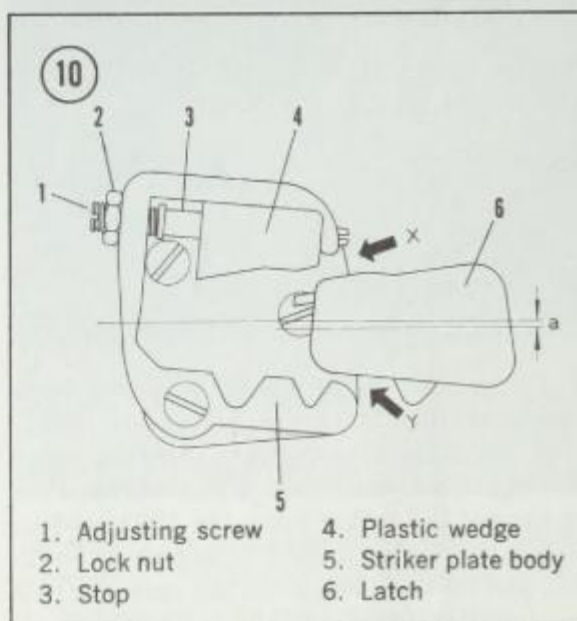
1. Remove the striker plate and check door alignment. If necessary, adjust the door. See Door Installation.

2. Install the striker plate. Slightly tighten the mounting screws.

3. Loosen the plastic wedge lock nut. Turn the adjusting screw (see **Figure 8**) clockwise until the stop is against the striker housing.

4. Close the door. If the door edge is not flush with the rear quarter panel, move the striker plate in or out to correct this. See **Figure 9**.

5. Adjust the striker plate vertically so that the gap at X is slightly greater than at Y. See **Figure 10**. When vertical alignment is proper, the latch housing (and door) will be lifted about 0.08"



(2mm) when the door is closed.

6. Open and close the door several times. Ensure that the bearing surfaces of the striker plate and latch contact each other evenly. Tilt the striker plate slightly if necessary to correct uneven contact.

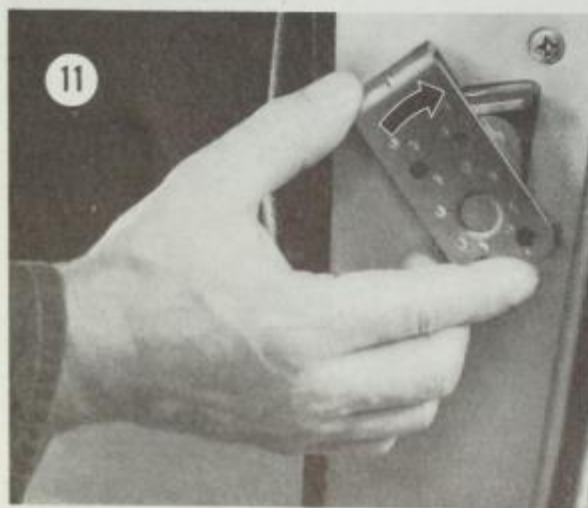
7. Tighten the striker plate screws.

8. Loosen the lock nut on the plastic wedge. While holding the lock nut with a wrench, adjust the screw counterclockwise to move the stop away from the striker plate housing. The adjustment is excessive if undue pressure is required to open the door, or if the door springs open when trying to close it. Tighten the lock nut when the adjustment is correct.

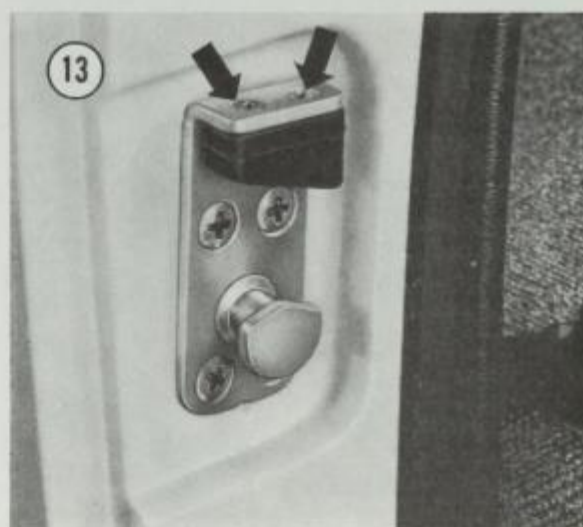
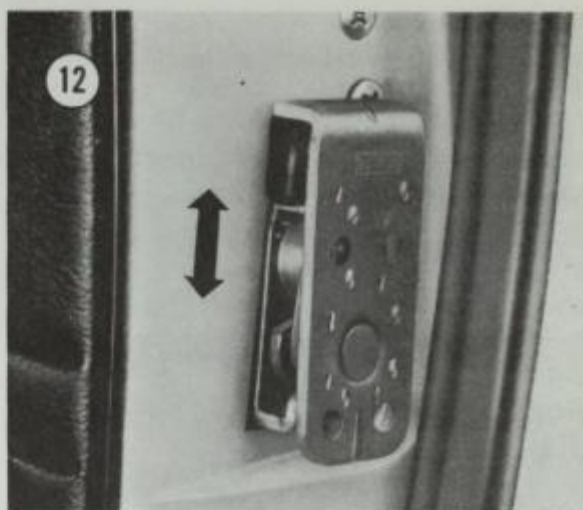
9. Lubricate bearing surfaces of the door latch and striker plate with vaseline or molybdenum disulphide paste.

Striker Plate Adjustment (1967-1972)

1. Remove the striker plate.
2. Insert the striker plate pin into the lock latch on the door and press the lock latch down into locking position.
3. Twist the striker plate upwards as shown in Figure 11.



4. Try to move the striker plate up and down (see Figure 12). If there is any play on 1967-1971 models, remove screws securing the wedge (see Figure 13), and insert a shim between the wedge and the striker plate. On 1972 models, replace the wedge if there is any play. To do this, pull the worn wedge out and press in a new one as shown in Figure 14.



5. With the striker plate removed, close the door and check alignment. Adjust door if necessary.
6. Install the striker plate and tighten the screws slightly.

7. Close the door. If the door edge is not flush with the rear quarter panel, move the striker plate in or out.

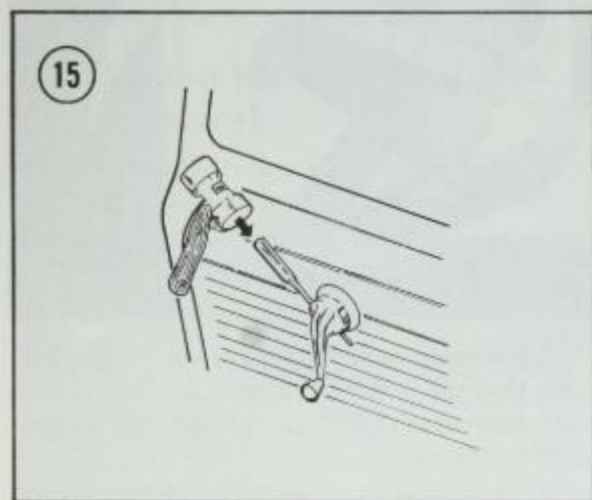
8. If the door is difficult to close, and the push-button is hard to operate, the top of the striker plate may be inclined too far inward. Loosen the screws and properly align the plate.

9. If the door springs back to the safety position when slammed, the top of the striker plate may be inclined too far outward. It is also possible the striker plate is too low. Realign the striker plate.

10. If the door is difficult to open and drops noticeably when opened, the striker plate is too high. Realign the striker plate.

Door Panel Removal/Installation

1a. On 1961-1966 doors, press window crank escutcheon against the upholstered panel. Drive the retaining pin out with a punch (Figure 15). Remove the crank and escutcheon.

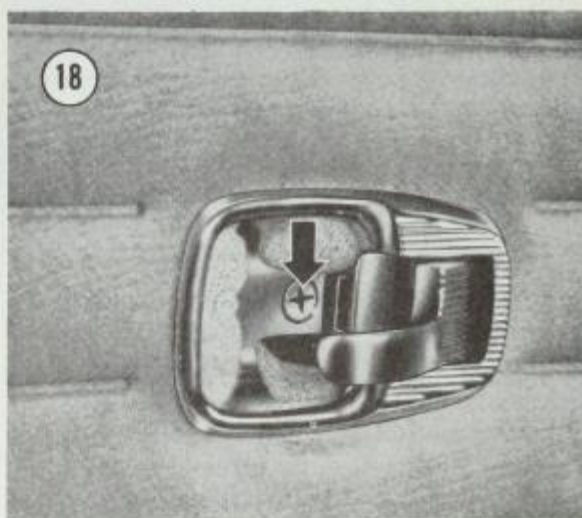
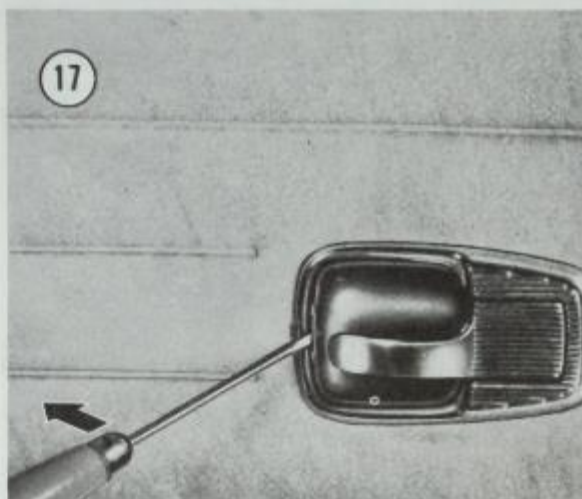
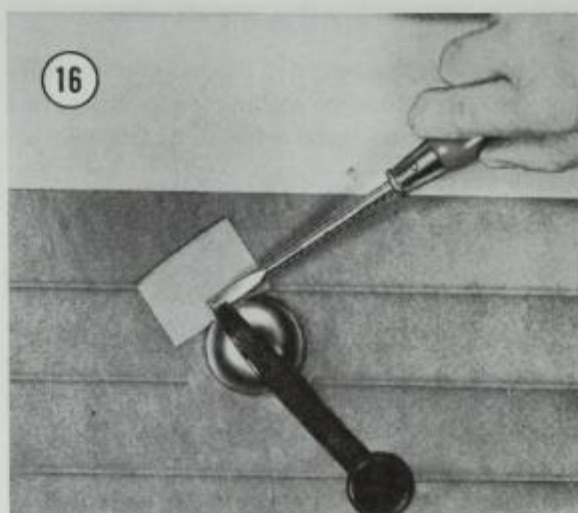


1b. On 1967-1972 doors, pry the plastic trim away from window crank as shown in Figure 16. Note the scrap wood used to protect the upholstery. Remove the phillips screw securing the window crank and remove the crank.

2a. On 1961-1966 doors, remove the inner door handle in the same manner as the window crank.

2b. On 1967-1972 doors, pry the recessed trim plate out as shown in Figure 17. Remove the phillips screw and escutcheon (Figure 18).

3. To remove the door panel upholstery, insert a wide blade screwdriver or similar object under



the edge of the panel and very carefully pry the panel away. Work slowly all around the panel.

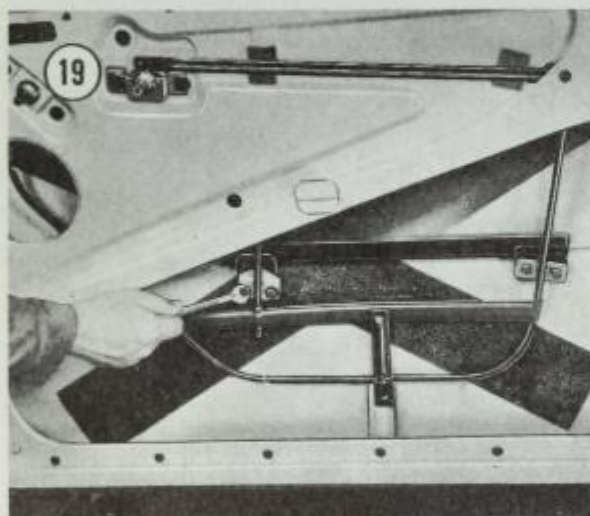
4. Installation is the reverse of these steps.

WINDOWS

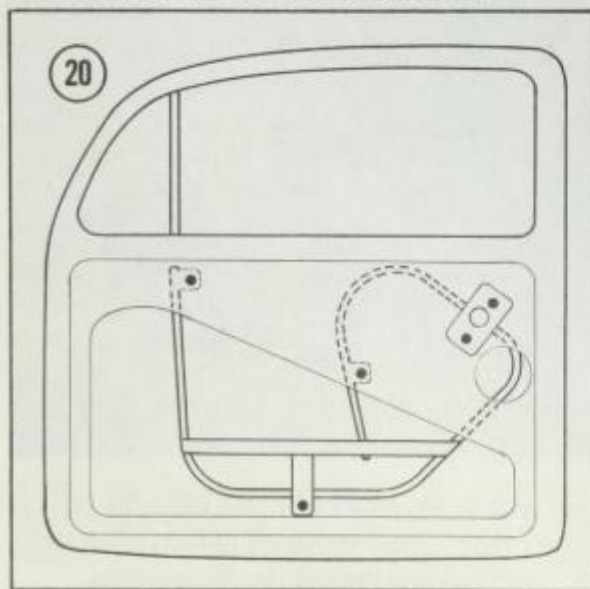
Window replacement is limited to door windows. Other windows require special skills and equipment. Take these jobs to your dealer or local glass shop.

Door Window Removal

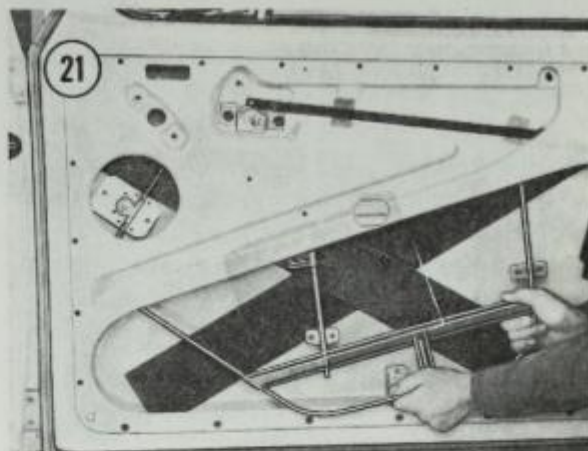
1. Remove the door panel as described previously.
2. Remove the door stop pin so the door can be opened fully. See Figure 1.
3. Remove the bolts securing the window lifter channel and glass to the window lifter mechanism. See Figure 19. Push the glass upwards.



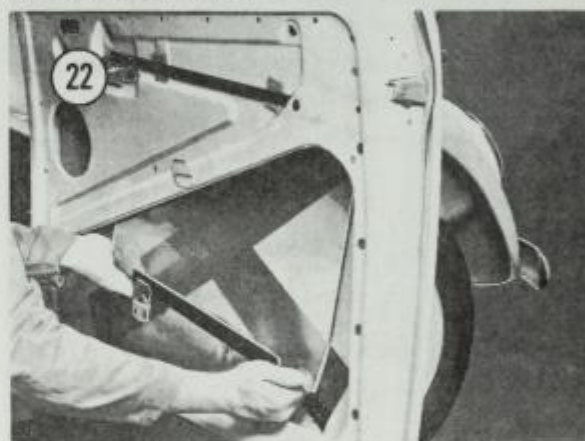
4. Remove 5 bolts securing the window lifter mechanism to the door. See Figure 20.



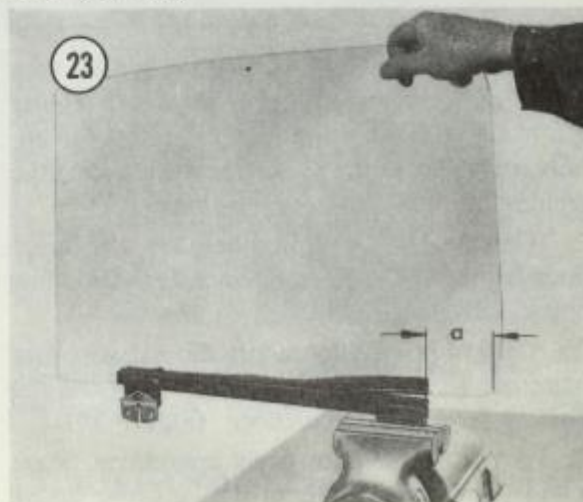
5. Pull the lifter mechanism out and down as shown in Figure 21 to remove it.



6. Pull the window glass down and out, as shown in Figure 22.



7. Installation is the reverse of these steps. Ensure that the glass is installed in the channel with dimension (a) shown in Figure 23 equal to 3.15" (80mm).



HOODS & LOCKS

Front Hood Removal/Installation

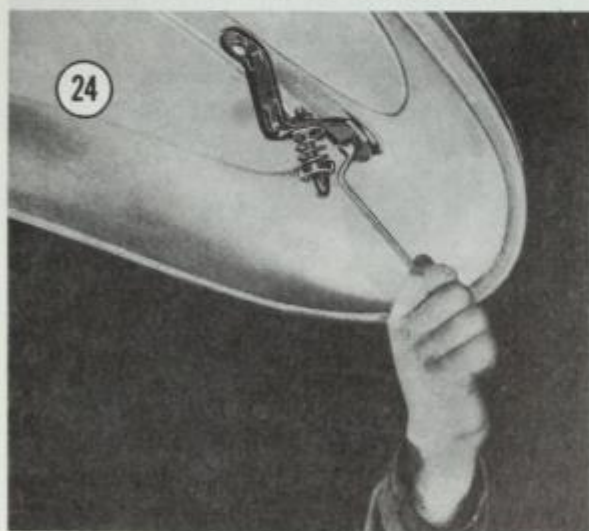
1. Open the hood.
2. Scribe marks on the hood around the hinges to aid in reassembly.
3. Remove bolts while a helper supports the hood.
4. Lift the hood off.
5. Installation is the reverse of these steps. Line up scribe marks for proper hood alignment.

Rear Hood Removal

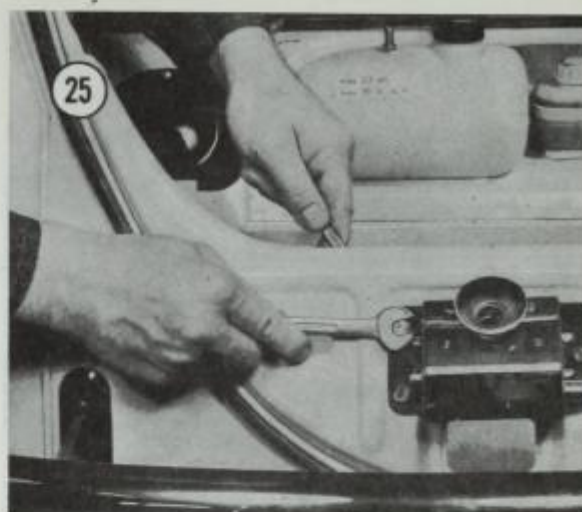
1. Open the hood.
2. Scribe marks on the hood around the hinges.
3. Disconnect the wires for the license plate light.
4. Remove bolts while a helper supports the hood.
5. Lift the hood off.
6. Installation is the reverse of these steps. Line up the scribe marks for proper alignment.

Front Hood Lock Replacement (1961-1967)

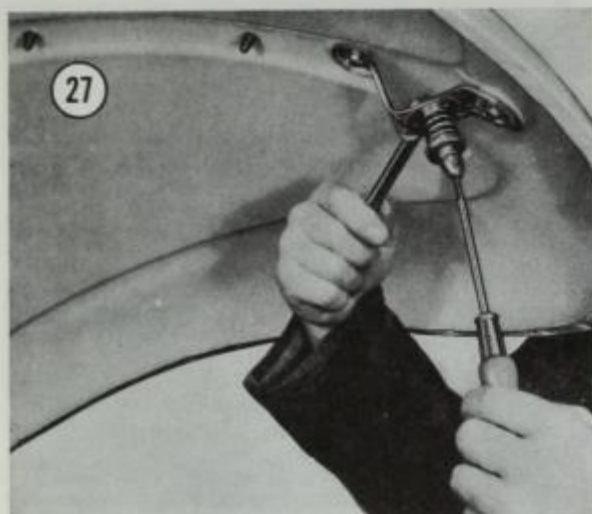
1. Open the hood.
2. Remove bolts securing upper part of lock. See **Figure 24**. Remove handle and lock bolt.



3. Remove bolts securing the lower part of the lock. See **Figure 25**.
4. Remove the cover plate on the lower part, and loosen the cable clamp screw (**Figure 26**). Remove the lock.

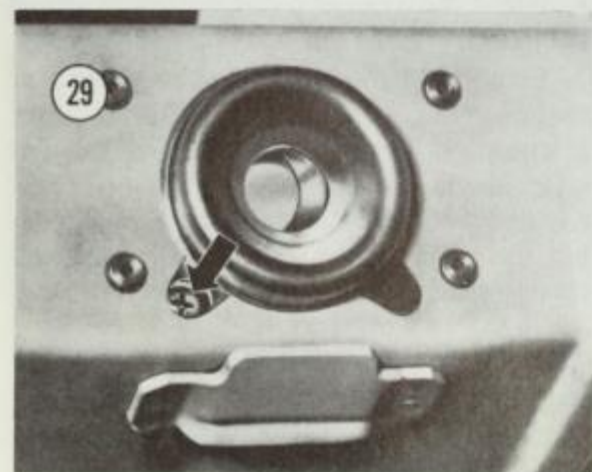


5. To install, push the lever containing the cable clamp screw counter to spring tension until the lever is directly under the lock bolt opening. Insert the cable in the lever and tighten the clamp screw. If the cable should break, the spring tension will automatically open the hood, ensuring easy repairs.
6. Install the cover plate on the lower part of the lock and install the lower part on the body.
7. Install the hood handle and upper part of the lock.
8. Open and close the hood several times to make sure that the lower part is centered properly and that the lock bolt is long enough. Adjust the lower part by loosening the bolts and moving the lower part. Adjust the lock bolt length as shown in **Figure 27**.
9. Check that the cable locks and unlocks the hood properly. If necessary, remove the cover plate and readjust the cable. Bend excess cable back so the cable can't slip out.

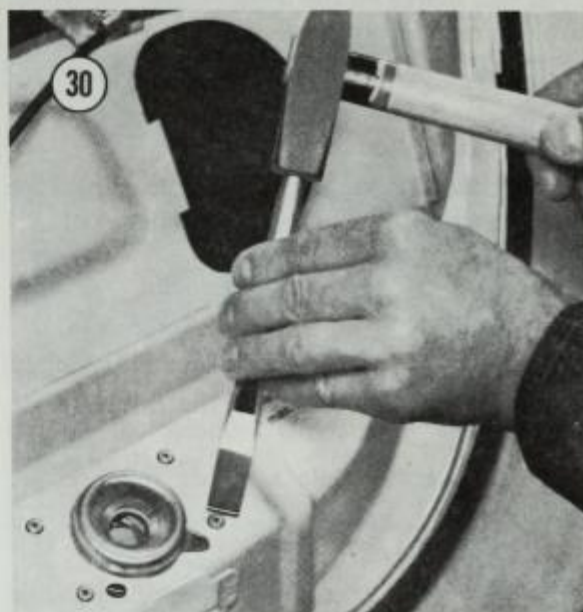


Front Hood Lock Replacement (1968-1972)

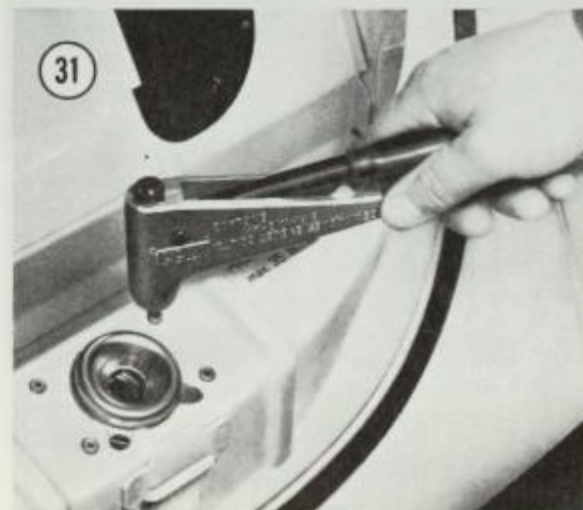
1. Open the hood.
2. Remove bolts securing upper part of lock to hood. See **Figure 28**. Remove handle and lock bolt.
3. Loosen the cable clamp screw (**Figure 29**).



4. Cut off the pop rivets on the lower part with a chisel or drill them out. See **Figure 30**. In either case, take care you don't damage the body.



5. Remove the lower part of the lock from below.
6. Lightly lubricate the lock parts.
7. Push the lock cable into the guide on the lower part and temporarily secure it with the clamp screw.
8. Attach the lower part to the body with pop rivets (see **Figure 31**) or nuts and bolts. Use lock washers on the bolts.



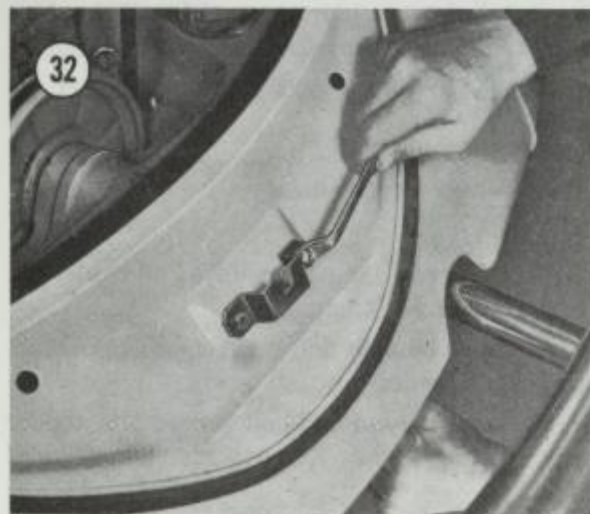
9. Loosen the clamp screw and pull the cable taut. Retighten the clamp screw.

10. Install the hood handle and upper part of the lock with plastic packing under the handle.

11. Open and close the hood several times to ensure it works properly. Adjust the length of the lock bolt if necessary by loosening the lock-nut and screwing the bolt in or out. Tighten the lock nut.

Rear Hood Lock Replacement

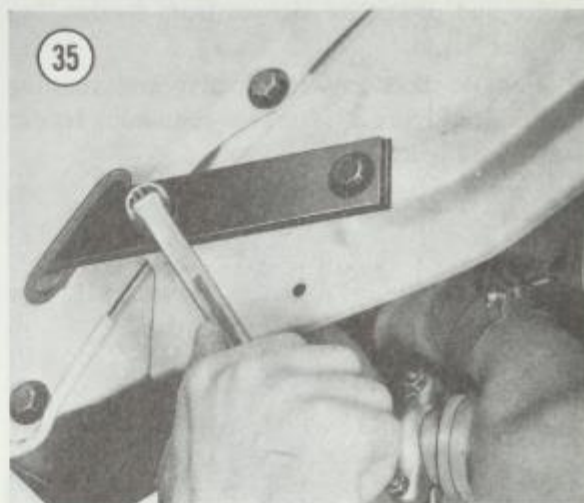
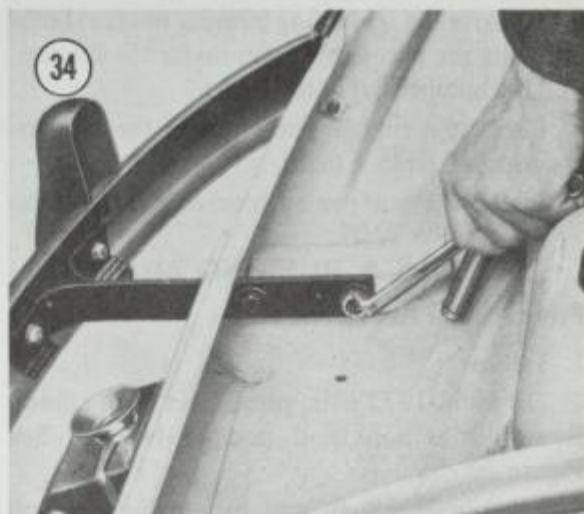
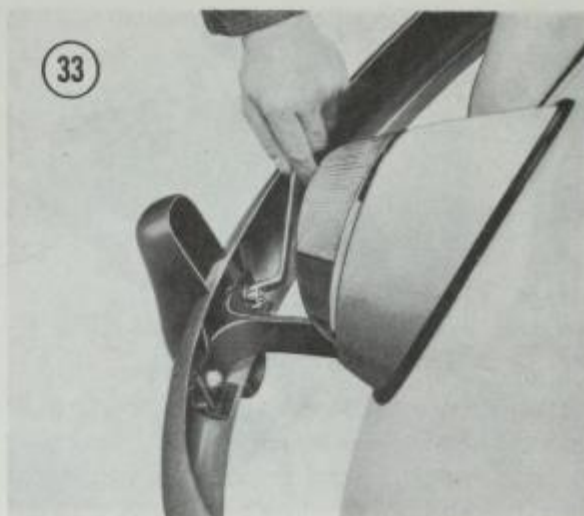
1. Open the rear hood.
2. Remove phillips head screws securing the lock and handle to the hood. Remove the lock and handle.
3. Install by reversing these steps. Use a new plastic packing if necessary.
4. Open and close the hood several times to ensure that the lock is positioned properly. If necessary, move the striker plate position (1961-1967). See **Figure 32**. On 1968-1972 models, adjust the upper lock position.



BUMPERS

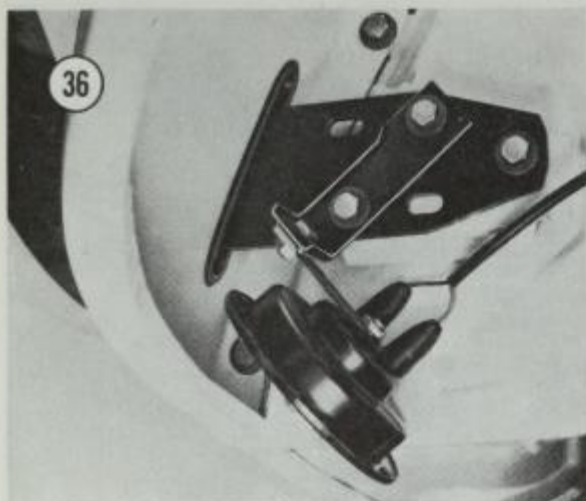
Bumper Replacement (1961-1967)

1. Open front hood and remove spare wheel.
2. Remove bolts securing the bumper to the bracket. See **Figure 33**.
3. Remove bolts securing brackets to the body. See **Figure 34** for front bumper and **Figure 35** for the rear bumper. Pull the bracket out through the fender.
4. When installing, check bracket seals. Replace if necessary. Then reverse these steps to install.



Bumper Replacement (1968-1972)

1. Remove 2 bolts securing the horn and bumper bracket on the left front side. See **Figure 36**.

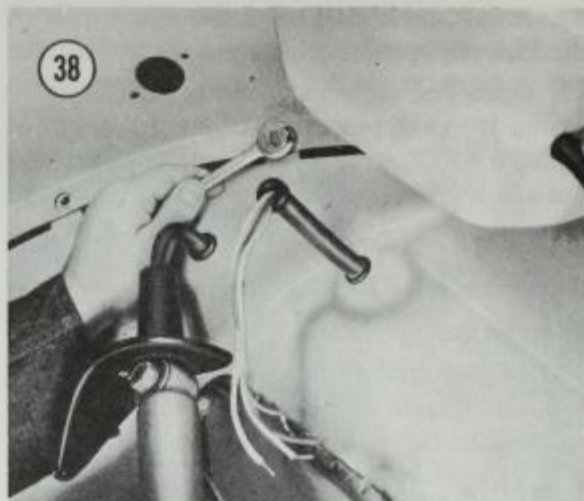
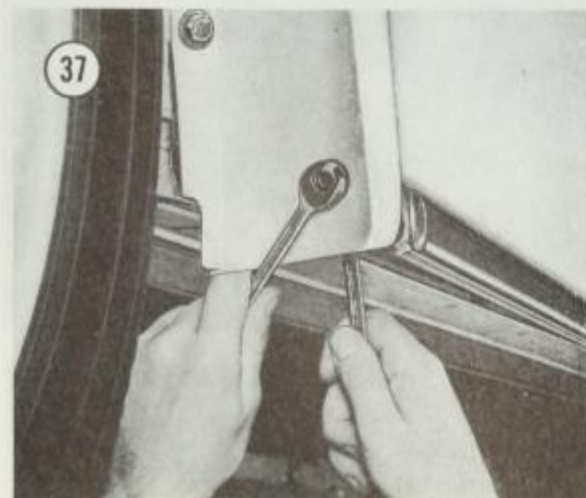


2. Remove the remaining bumper bracket bolts. All bolts are accessible from under the fenders. Pull the bumper out of the fender.
3. Check the rubber grommets in the fenders. If damaged, replace them.
4. Install the bumper by reversing these steps.

FENDERS & RUNNING BOARDS

Front Fender Replacement

1. Lift car.
2. On 1968-1972 cars, disconnect horn cables. Remove the horn and bumper bracket. See Figure 36.
3. Remove headlight and turn indicator. Pull cables and protective sleeves from fender. See Chapter Seven.
4. Remove bolt between fender and running board. See Figure 37. Remove remaining fender bolts. See Figure 38.



5. Remove fender and beading.
6. Install the fender with beading. Use new beading if necessary.
7. Install the bolt between the fender and running board with a new rubber washer.
8. Install the turn indicator and headlight. Aim the headlights as described in Chapter Seven.
9. Install the horn and bumper bracket on 1968-1972 cars.

Rear Fender Replacement

1. Lift car.
2. Remove rear lamp assembly. Pull cables out of the fender. See Chapter Seven.
3. Remove bumper and brackets. Take bracket seal out of fender.
4. Remove the nut and bolt between the fender and running board. Remove remaining fender bolts.
5. Remove fender and beading.
6. Install the fender with beading. Use new beading if necessary.
7. Install the bolt and nut between the fender and running board. Use a new rubber washer.
8. Install the rear lamp assembly, and connect the cables. Use a new gasket if necessary.
9. Install the bumper bracket seals, brackets, and rear bumper.

Running Board Replacement

1. Remove bolts securing each end of the running board to the fenders.

2. Loosen the bolts securing the running board to the body. See **Figure 39**.



3. Lift the running board up and remove it.

4. Install the new running board on the body bolts.

5. Install the bolts at each end loosely. Use new rubber washers.

6. Tighten the bolts securing the running board to the body. Then tighten the end bolts.

SUN ROOF & CONVERTIBLE TOP

Adjustments and repairs to these tops are difficult without considerable experience. Minor leaks can quickly become major leaks after incorrect adjustments. If leaks or drafts develop, take the job to your dealer or local shop specializing in these repairs.

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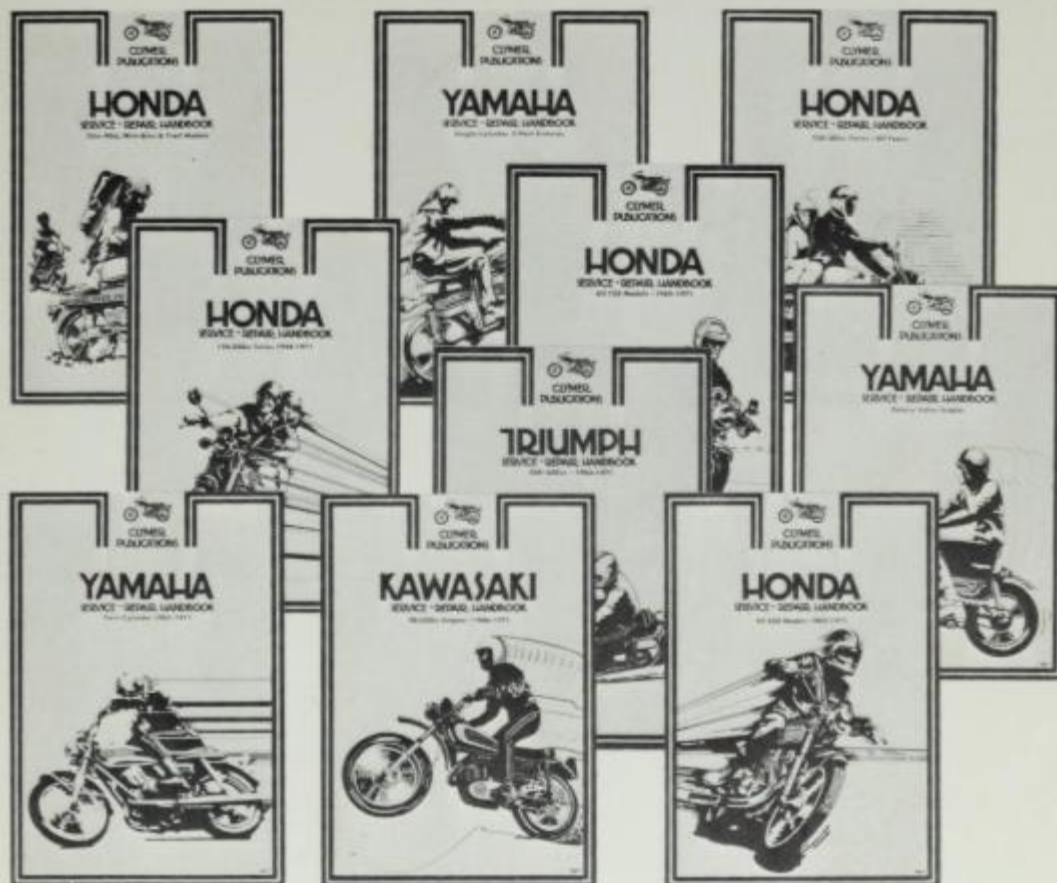
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